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THE METRIC SYSTEM

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THE

METRIC SYSTEM

THE
METRIC SYSTEM

EXPLAINED

With Exercises, Examples and Illustrations

BY

GEORGES ROUSSELLE

Teacher in the Paris Communal Schools

PUBLISHED UNDER THE PATRONAGE

of the

British Chamber of Commerce at Paris

TRANSLATED AND ADAPTED

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Head Master of the Paris British Schools.

PARIS

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1896

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Vignaud
2.-2.6-27

PRÉFACE

The advantages of a uniform system of weights, measures and money, proceeding decimally for the multiples and submultiples of the different units are acknowledged on all hands.

In furthering the adoption of such a system among the nations, we have aimed at honouring France and rendering a service to all.

The Exhibition of 1900 will soon be a thing of the present. May we venture to hope that the world-wide acceptation of the Metric System before that date will help forward the idea of a

Tous les peuples sont aujourd'hui unanimes à reconnaître les avantages d'un système uniforme de poids, de mesures et de monnaies procédant pour les multiples et les subdivisions des différentes unités suivant les règles des nombres décimaux.

En cherchant à le faire pénétrer chez les autres peuples, nous croyons à la fois leur rendre service et honorer la France.

A la veille d'ouvrir à Paris la grande Exposition de 1900, nous espérons que l'adoption universelle du Système métrique sera comme un

universal language and contribute towards a reign of peace for all people.

In any plan of adopting this admirable System, its use in schools must come first and here we need the most practical exposition possible.

Our metric model, illustration of which will be found on P. XI has been proved by long and widespread use not only in Paris, France and the colonies, but in all countries using the Metric System, to be by far the best instrument for making clear to masters and scholars alike every detail in the Metric System.

The following lesson indicates to teachers the line to be followed.

signe de paix entre tous les peuples et un premier pas fait vers l'adoption d'une langue universelle.

Mais il ne suffit pas d'adopter ce merveilleux Système, il faut en faire pénétrer l'usage dans les masses, en commençant par l'enseigner à l'école.

Notre meuble métrique, si apprécié dans les écoles, non seulement à Paris et dans la France entière et ses colonies, mais dans tous les pays qui ont adopté le Système métrique, et dont nous reproduisons ici le dessin, est l'instrument par excellence pour familiariser en peu de temps les maîtres et les élèves avec ce nouvel enseignement.

La leçon ci-après en fera comprendre toute la valeur pratique.

GEDALGE.

We are glad to publish the following letter from a member of the British House of Commons :

Dear Mr Rousselle,

I am very glad that you have expanded into pamphlet form the admirable lecture you delivered at Kidderminster last year. If any of those who then heard you had any doubt as to the simplicity of the Metric System your lucid exposition of it must have cleared that doubt away. Since your departure the question has been often discussed among my constituents and the appearance of your brochure will be hailed with pleasure by many who could not attend the meeting. I may add that those interested in educational matters here are unanimously in favour of the immediate introduction of the System. By such treatment as the subject has received at your hands the passage of the Bill to legalize the use of Weights and Measures of the Metric System will be much facilitated.

It is now before the House of Commons and I trust before long will become law.

Heartily wishing you that success you so well deserve.

Sincerely yours,

A.-F. GODSON, *M.P.*

Droitwich, 17 Oct. 1896,

NEW METRIC COMPENDIUM WITH BALL-FRAME

INDISPENSABLE FOR THE STUDY OF THE METRIC SYSTEM

This Compendium [1] includes :

1. A **ball-frame**[2] with **three sheets** shewing with great clearness the principles of *numeration.*
2. **Two other sheets** giving:
   a) *Illustrations of the different metric weights and measures* and the *terrestrial globe;*
   b) Enumeration of the *metric units,* their multiples and sub-multiples, and the *list* of the *tangible weights and measures.*
3. **All the tangible measures** in actual use of the metric System.

LIST OF THE WEIGHTS AND MEASURES

contained in the Compendium

and the method of using them

(The actual handling of these will fix the System indelibly in the memory.)

MEASURES OF LENGTH

(See Metric System, page 7.)

1. **Terrestrial globe.** — The teacher can use this to shew the *origin of the metre* and how its length was fixed.

---

(1) The metric Compendium (1^m80 high by 0^m77 wide) is mounted on wheels and can easily be rolled from class to class.

(2) The ball-frame is fixed above the Compendium, but can be taken off and used separately.

2. **Linear metre.** — The teacher will take the rule wich represents the linear metre and shew the pupils that it is divided :

   On one of its faces into two equal parts, each *half a metre;*

   Upon another face into ten equal parts called *decimetres;*

   Upon a third face the decimetres are divided into ten equal parts called *centimetres;*

   And lastly upon a fourth face, the centimetres are divided into ten equal parts, or *millimetres.*

3. **A wooden folding metre** (see p. 14), with ten divisions each one decimetre long.

4. **A metal decametre** (*surveyor's chain*) of fifty links each 2 decimetres long.

Make each pupil measure the tables, desks, walls, books, etc., and give the dimensions orally and in writing, in metres, decimetres, centimetres or millimetres as the case may be

MEASURES OF SURFACE

(See Metric System, page 23.)

5. **SQUARE METRE.** — In order to study the square metre, the *frame hinged* to the back of the Compendium must be opened out. We have then before us *four lateral faces* each representing one *square metre.*

   The edges of each face are differently divided:

   The 1st into *decimetres;*

   The 2nd into *decimetres,* and *half decimetres;*

   The 3rd into *decimetres, half decimetres, centimetres* and *half centimetres;*

   The 4th into *centimetres, half centimetres* and *millimetres.*

6. **Square decimetre.** — A square decimetre divided into 100 equal parts will be of use to the teacher to shew that *the square decimetre contains 100 square centimetres,* since each of these 100 parts represents a square with sides one centimetre long.

7. **Flat ruler.** — A flat ruler is enclosed, one metre long by one decimetre wide. The teacher will shew that this ruler contains exactly 10 times the square deci-

metre mentioned above and consequently that it has a *surface of* 10 *square decimetres or of* 1000 *square centimetres*. — By applying this ruler to one of the edges of the square metre he can easily shew that it is contained exactly 10 times on the surface of the square metre; thus the pupils can see that the square metre contains 10 times 10 or 100 *square decimetres*, or 10,000 *square centimetres*, and that the units of surface are each 100 times greater or less than its neighbouring unit.

MEASURES OF VOLUME

(See Metric System, page 47.)

8. **CUBIC METRE.** — Having opened out the *hinged frame*, as for the study of the square metre, the teacher can show his pupils the *exact shape of the cubic metre, i. e.* a cube with six faces (4 vertical and 2 horizontal), each one square metre.

9. **Metal cubic decimetre.** — By means of this decimetre, which can be fixed to one end of the *flat ruler*, it is easy to see that the cubic metre contains the cubic decimetre exactly 1,000 times.

10. **Hollow model of 100 cubic centimetres.** — This is for shewing that it is contained exactly 10 times in the cubic decimetre, and so the latter contains 10 times 100, or 1,000 cubic centimetres.

In this manner it is easily seen that *the units of volume proceed by thousands.*

MEASURES OF CAPACITY

(See Metric System, page 65.)

Litre [1]. — This, the chief unit of capacity has a con-

(1) In the glass case will be found :

11. **Three litres of different form** (one for alcohols, one for milk, and one for seeds, grain, etc.
12. **A half decalitre.**
13. **A double litre.**
14. **A half litre.**
15. **A double decilitre.**
16. **A decilitre.**
17. **A half decilitre.**
18. **A double centilitre.**
19. **A centilitre.**

tent equal to that of a cubic decimetre. To shew this, the teacher fills the cubic decimetre with fine sand, empties it into the litre and shows that the latter is exactly full.

To familiarise the pupils with the measures of capacity, the teacher should cause the latter to be estimated by comparison. For instance, the pupil can fill the decilitre exactly 10 times from the litre, and thus understand that the decilitre is the tenth part of the litre, etc., etc.

WEIGHTS

(See Metric System, page 83.)

20. **Ten metal cubic centimetres.** — The *gramme* [1], chief unit, is the *weight of a cubic centimetre of pure water distilled at 4° C.*

To shew this, the teacher attaches to one arm of a scale the 10 cubic centimetres, then heaps up sand on the other plate of the scale, until equilibrium is established.

Then fill one of the 10 cells (cubic centimetres) with distilled water, and the equilibrium is destroyed.

Now, to reestablish it, place a one gramme weight on the sand.

---

(1) The glass case of the Compendium also contains:

21. A series of **copper weights**:

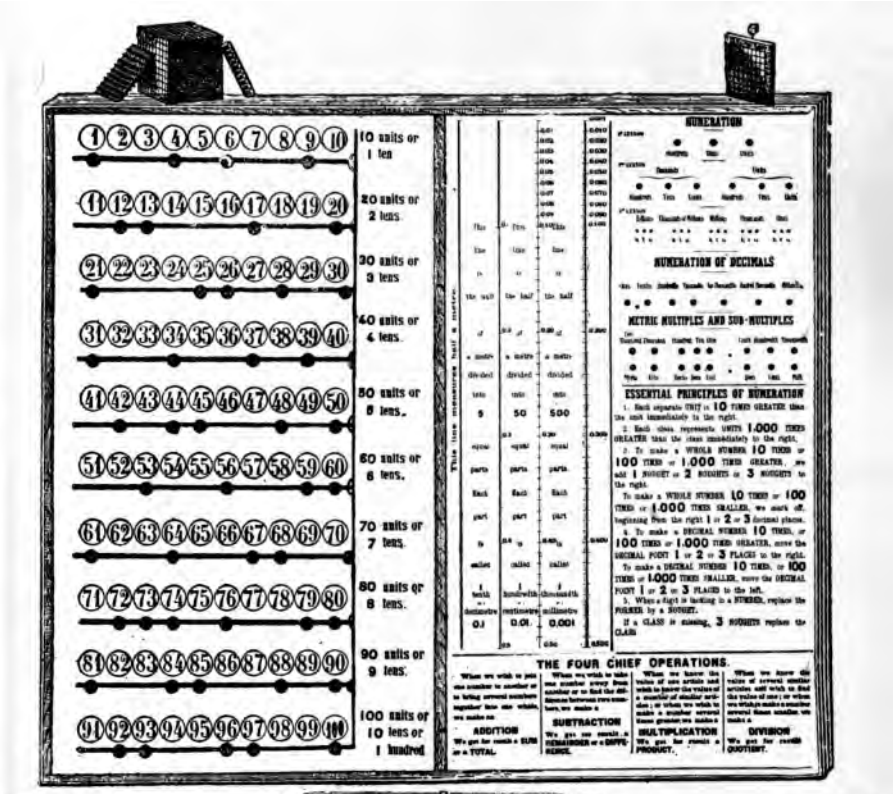
1gr, 2gr, 5gr, 10gr, 20gr, 50gr, 100gr, 200gr, 500gr.

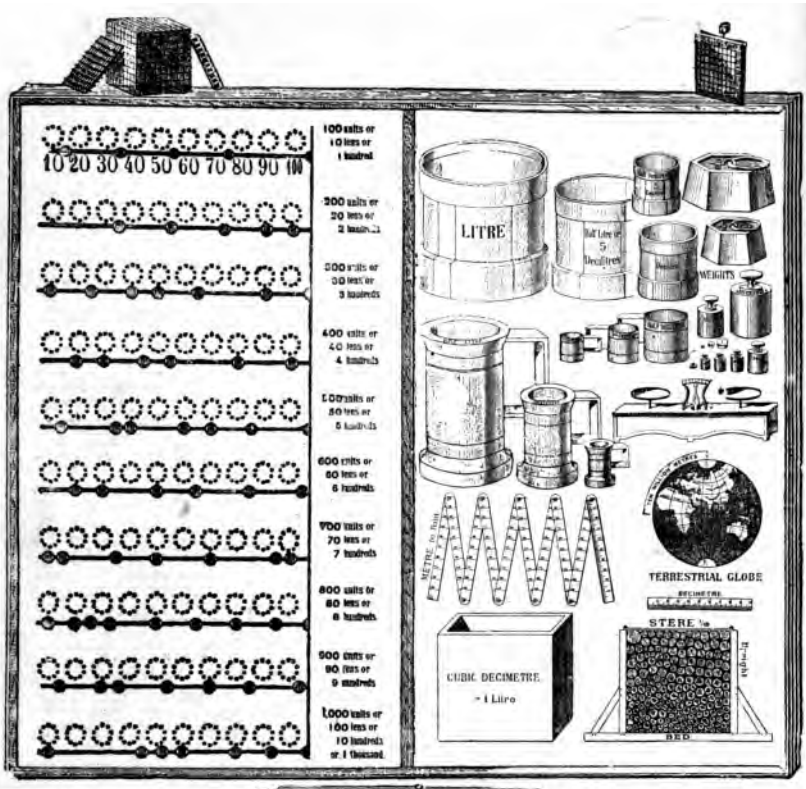
22. A series of **cast iron weights**:

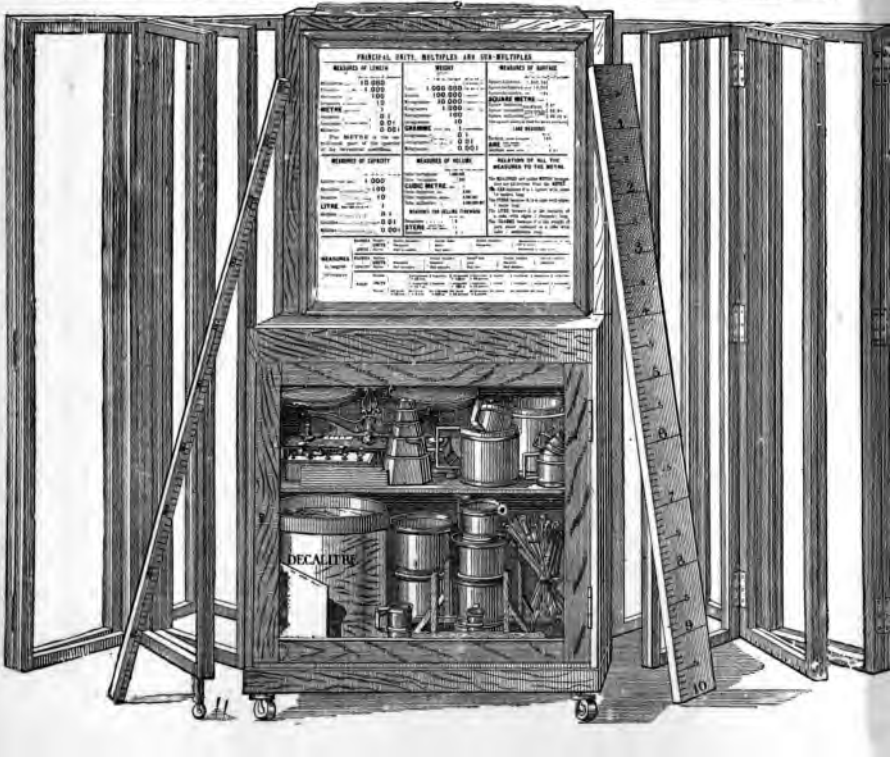
$\frac{1}{2}$ hectogr., 1 hectogr., 2 hectogr., $\frac{1}{2}$ kilog, 1 kilog.

23. A **scale** for comparing the weights one with another.

Price, complete, £ 5.


1 2 3 4 5 6 7 8 9 10
10 units or 1 ten
11 12 13 14 15 16 17 18 19 20
20 units or 2 tens
21 22 23 24 25 26 27 28 29 30
30 units or 3 tens
31 32 33 34 35 36 37 38 39 40
40 units or 4 tens
41 42 43 44 45 46 47 48 49 50
50 units or 5 tens.
51 52 53 54 55 56 57 58 59 60
60 units or 6 tens.
61 62 63 64 65 66 67 68 69 70
70 units or 7 tens.
71 72 73 74 75 76 77 78 79 80
80 units or 8 tens.
81 82 83 84 85 86 87 88 89 90
90 units or 9 tens.
91 92 93 94 95 96 97 98 99 100
100 units or 10 tens or 1 hundred
NUMERATION
NUMERATION OF DECIMALS
METRIC MULTIPLES AND SUB-MULTIPLES
ESSENTIAL PRINCIPLES OF NUMERATION
THE FOUR CHIEF OPERATIONS.
ADDITION
SUBTRACTION
MULTIPLICATION
DIVISION
DECALITRE


10 20 30 40 50 60 70 80 90 100
100 units or 10 tens or 1 hundred
200 units or 20 tens or 2 hundreds
300 units or 30 tens or 3 hundreds
400 units or 40 tens or 4 hundreds
500 units or 50 tens or 5 hundreds
600 units or 60 tens or 6 hundreds
700 units or 70 tens or 7 hundreds
800 units or 80 tens or 8 hundreds
900 units or 90 tens or 9 hundreds
1,000 units or 100 tens or 10 hundreds or 1 thousand
LITRE
Half Litre or 5 Decilitres
WEIGHTS
METRE in Iron
TERRESTRIAL GLOBE
DECIMETRE
CUBIC DECIMETRE = 1 Litre
STERE
Metre in length
BED


PRINCIPAL UNITS, MULTIPLES AND SUB-MULTIPLES
MEASURES OF LENGTH
WEIGHT
MEASURES OF SURFACE
SQUARE METRE
MEASURES OF CAPACITY
MEASURES OF VOLUME
CUBIC METRE
LITRE
STERE
RELATION OF ALL THE MEASURES TO THE METRE.
DECALITRE

THE METRIC SYSTEM

CHAPTER I

DEFINITION

We use weights and measures to estimate sizes.

Weights are employed for weighing bread, meat, and other substances. **Measures** are used for finding out the length of a ruler, a road, the contents of a vessel, etc.

The **Metric system** is the group of weights and measures having for basis a fundamental measure or fixed standard : the **metre.**

It is called **metric** because all the measures are derived from the metre;

And also **decimal** because all the units of the same kind are each ten times, one hundred

times, or one thousand times greater or less than the neighbouring sub-multiple or multiple respectively.

The Metric system presents numerous advantages :

It is **uniform** : all the measures have every where the same value. The Paris metre is identically the same as the Brussels or Berne metre.

It is **simple** : the various measures are 10, 100 or 1,000 times larger or smaller one than the other, as shewn above.

It is **unchangeable** : each measure has always the same value since all depend logically on the metre.

The advantages of the Metric system are so great that France, Italy, Belgium, Switzerland, Greece, Austria, Roumania, Egypt, Turkey, Germany, Spain, the Netherlands, Portugal, Sweden, Norway and almost all South America have adopted it.

It is to be desired that we should as quickly as possible follow the example of the above mentioned countries and do away with a system of weights and measures which we all find so defective.

Our system lacks :

1. **uniformity :** the measures not being the same all over Great Britain.

2. **simplicity :** some measures being divided into 8 or 40 equal parts, others into $5\frac{1}{2}$ or $30\frac{1}{4}$ equal parts.

Thus for measures of length :

The mile equals 8 furlongs, the furlong, 40 poles and the pole $5\frac{1}{2}$ yards.

Much difficulty is therefore experienced in calculating.

3. **stability :** our measures not always having had the same value.

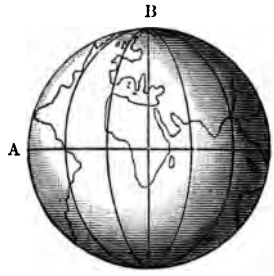
When the Metric system was decreed by the « Assemblée Constituante », it was decided to take for a base a fixed natural standard.

By means of this fixed standard all the other measures have been established.

This fixed standard or basis is a part of the length of the meridian.

To this effect, Delambre and Méchain, two French scientists, were appointed to measure the length of the arc of the meridian between Dunkirk and Barcelona.

From the figures they gave, the length of the quarter of the terrestrial meridian was deduced and was found equal to 5,130,740 toises[1]; the ten millionth part of the result, or $\frac{5,130,740}{10,000,000}$ gave one **metre**.



A B : quarter of the terrestrial meridian measures 10,000,000 metres.

All meridians being equal, the result would have been the same, if they had measured the Meridian of Greenwich.

UNITS OF THE METRIC SYSTEM.

The principal units are :

The **metre**	for *lengths*.
The **square metre** and the **are**	for *surfaces*.
The **cubic metre** and the **stere**	for *volumes*.
The **litre**	for *contents*.
The **gramme**	for *weights*.

1. Toise : 6.39459 feet.

The secondary units (*multiples* and *sub-multiples*) have been established as follows :

Those having a greater value than the principal unit are denoted by terms derived from the Greek, prefixed to the name of the principal unit :

Deca,	contracted *D*,	means	**10**	times
Hecto,	— *H*,	—	**100**	—
Kilo,	— *K*,	—	**1,000**	—
Myria,	— *M*,	—	**10,000**	—

So that a **deca***metre* is equal to 10 metres, one **hecto***litre* to 100 litres, and so on.

The secondary units smaller than the principal unit are denoted by terms derived from the Latin, prefixed to the name of the principal unit :

Deci,	contracted *d*,	means	*one tenth.*
Centi,	— *c*,	—	*one hundredth.*
Milli,	— *m*,	—	*one thousandth.*

Consequently one **centi***litre* is the hundredth part of the litre; one **milli***gramme*, the thousandth part of the gramme.

CHAPTER II

MEASURES OF LENGTH

The metre.

The principal unit of the *measures of length* is the **metre**[1] (*m*).

We have read above that to obtain the length of the metre the quarter of the length of the terrestrial meridian was divided into ten million equal parts.

The metre is the ten millionth part of the quarter of the terrestrial meridian.

The terrestrial meridian measures forty million metres.

1. Taken from the Greek *metron*.

MULTIPLES OF THE METRE

The secondary units greater than the metre or **multiples** of the metre are :

The **deca***metre* (*Dm*)	or length of	**10** metres.
The **hecto***metre* (*Hm*)	—	**100** —
The **kilo***metre* (*Km*)	—	**1,000** —
The **myria***metre* (*Mm*)	—	**10,000** —

Remark I.—The multiples of the metre are the units which are each ten times larger than the next lower multiple :

The decametre	equals	**10** metres.
The hectometre	—	**10** decametres.
The kilometre	—	**10** hectometres.
The myriametre	—	**10** kilometres.

Remark II.—It is therefore easy to see that :

The myriametre equals 10^{Km} or 100^{Hm} or $1{,}000^{Dm}$ or $10{,}000^{m}$.
The kilometre equals 10^{Hm} or 100^{Dm} or $1{,}000^{m}$.
The hectometre equals 10^{Dm} or 100^{m}.
The decametre equals 10^{m}.

SUB-MULTIPLES OF THE METRE

The secondary units less than the metre or **sub-multiples** of the metre are :

The **deci***metre* (*dm*) or *tenth* part of the metre (**0^{m}.1**).

The **centi***metre* (*cm*) or *hundredth* part of the metre (**0^{m}.01**).

The **milli***metre* (*mm*) or *thousandth* part of the metre (**0^{m}.001**).

Remark. — Each sub-multiple is ten times smaller than its immediate left-hand neighbour.

The centimetre is the tenth part of the decimetre.

The millimetre is the tenth part of the centimetre.

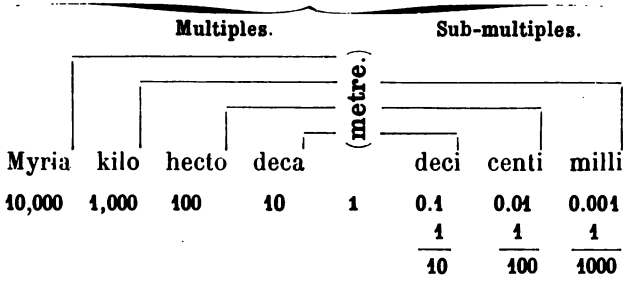
Or again we find :

10^{dm} or 100^{cm} or $1{,}000^{mm}$ in one metre;

10^{cm} or 100^{mm} in one decimetre;

10^{mm} in one centimetre.

RECAPITULATORY TABLE OF THE MEASURES OF LENGTH



TO READ A NUMBER EXPRESSING LENGTH

To read a number expressing length, read first the whole part, to which you give the name of the principal unit, then read the decimal part adding the name of the last units it contains.

Examples :

1. $415^{m}.12$,

read :

Four hundred and fifteen metres and twelve centimetres.

2. 83^{m},

read :

Eighty three metres.

3. $0^{m}.18$,

read :

0 metres 18 centimetres.

And lastly :

$13^{Km}.843$, read : 13 kilometres 843 metres ;
$6^{Hm}.23$, — 6 hectometres 23 metres;
$8^{Dm}.5$, — 8 decametres 5 metres;
$4^{Dm}.07$ — 4 decametres 7 decimetres.

TO WRITE A NUMBER EXPRESSING LENGTH

To write a number expressing length, write first the principal units, place the decimal point, and then the decimal part, taking care to replace by noughts the units which are missing.

Examples :

1. For 224 metres 53 centimetres, write : $224^{m}.53$;
— 8,432 metres 115 millimetres, — $8,432^{m}.115$;
— 15 hectometres 4 decametres, — $15^{Hm}.4$;
— 14 kilom. 120 metres, — $14^{Km}.120$.

2. For 73 metres 8 centimetres, write : $73^{m}.\mathbf{0}8$.

The nought (**0**) replaces the decimetres which are missing.

For 124 metres 7 millimetres, write : $124^{m}.\mathbf{00}7$;

The two noughts (**00**) replace : — the first one the decimetres, the second one the centimetres which are missing.

For 0 metres 25 centimetres, write : $\mathbf{0}^{m}.25$.

The metres not being expressed are replaced by a nought (**0**).

For 8 kilometres 26 metres, write : $8^{Km}.\mathbf{0}26$.

The nought (**0**) replaces the hectometres.

Remark.—To read and write a number representing length, notice that the units of length succeed each other from right to left, from the smallest to the highest as shewn in the recapitulatory table of the measures of length.

CHANGING THE UNIT

We may have to write a number representing units of a certain order in units of another order, for example, to write in *kilometres* a number representing metres.

This is what is called *reducing* a number to units of another order.

RULE.—To reduce a number to units of another order, carry the decimal point to the right hand of the figure of the required units, 1, 2, 3, 4... places either to the right or to the left.

Examples :

1. Reduce $2{,}123^{m}.7$ to *kilometres*.

The kilometres occupy the third place to the left hand of the metres, carry the decimal point three places to the left and we have.

$$2^{Km}.1237.$$

2. Reduce to *decametres* the number $8^{m}.17$.

The decametres occupy the first place to the left hand of the metres, we must carry the decimal point one place to the left hand and as the decametres are not expressed, replace them by a nought (**0**) and we get :

$$0^{Dm}.817.$$

3. Write $5^{m}.25$ in *centimetres.*

The centimetres occupy the second row to the right hand of the metres, carry the decimal point two places to the right to obtain :

525 centimetres.

4. Convert into *metres* $46^{Km}.3$.

The kilometres being taken as units, the metres occupy the third row on the right, carry the decimal point three rows to the right and as there is only one figure add two noughts (**00**) and the result is :

46,3**00** metres.

Again :

125 centimetres equal $1^{m}.25$.
$4^{Dm}.8$ metres — 48^{m}.

CHOICE OF A UNIT OF LENGTH

The unit of length varies according to the article measured.

The *metre* is taken for unit to estimate the length of a wall or of a piece of linen.

The *centimetre* is the unit chosen for measuring building work, the width of a window, or the dimensions of a plank.

The *millimetre* is the unit employed to represent the thickness of a piece of glass, marble, or iron.

For measuring a field or a piece of land a *decametre* (10 metres) is used.

Long Distances. — To express the length of a road, of a line or of a railway, the principal measure is :

The *kilometre* or 1,000^{m}.

The other measures less used are the *myriametre* and the *hectometre.*

We say that a road is 10 kilometres long, that an engine travels 70 kilometres an hour.

ACTUAL MEASURES OF LENGTH

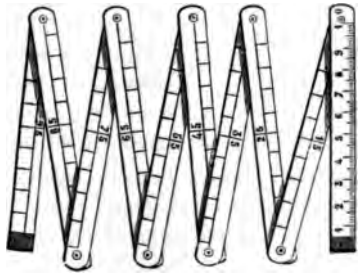
The measures of length do not all really exist in concrete form.

The measures of length in use in trade and for industrial purposes are those which are said to be *actual* or *effective :*

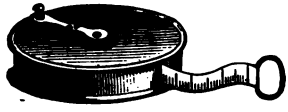
These measures are :

The **double decametre**	or 20 metres	Made of tape or links connected by rings.
The **decametre**	or 10 metres	
The **double metre**	or 2 metres	Made of wood in one piece or to fold.
The **metre**		
The **half metre**	or 0^{m}.50	
The **double decimetre**	or 0^{m}.20	Wood or ivory.
The **decimetre**	or 0^{m}.10	

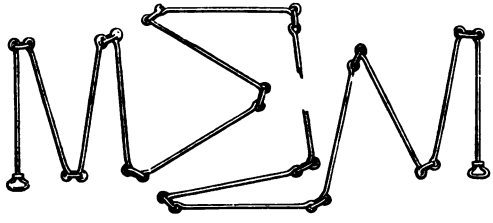
Decimetre (exact size)
divided into 10 centimetres and into 100 millimetres.



Metre to fold ($\frac{1}{3}$).



Metre to wind.



Decametre made of links connected by rings.

EXERCISES ON THE MEASURES OF LENGTH

Exercise 1.

To read numbers expressing lengths.

For $4^{m}.75$, read : 4 metres 75 centimetres.
— $837^{Km}.655$ — 837 kilometres 655 metres.
— $87^{Dm}.7$ — 87 decametres 7 metres.
— $17^{Hm}.7$ — 17 hectometres 7 decametres.
— $18^{Km}.74$ — 18 kilometres 74 decametres.
— $7^{Dm}.65$ — 7 decametres 65 decimetres.
— $7^{Km}.8$ — 7 kilometres 8 hectometres.
— $8^{Mm}.43$ — 8 myriametres 43 hectometres.

For $0^{m}.45$, read : 0 metres 45 centimetres and also 45 centimetres
— $0^{m}.7$ — 0 metres 7 decimetres — 7 decimetres.
— $0^{m}.465$ — 0 metres 465 millimetres — 465 millimetres.

For $3^{dm}.5$, read : 3 decimetres 5 centimetres.
— $4^{cm}.8$ — 4 centimetres 8 millimetres.
— $3^{dm}.84$ — 3 decimetres 84 millimetres.
— $14^{cm}.7$ — 14 centimetres 7 millimetres.

Exercise 2.

To write numbers expressing lengths.

For 8 metres 5 decimetres write : $8^{m}.5$.
— 17 kilometres 175 metres — $17^{Km}.175$.
— 18 hectometres 37 metres — $18^{Hm}.37$.
— 7 decametres 5 metres — $7^{Dm}.5$.
— 37 centimetres 3 millimetres — $37^{cm}.3$.
— 6 myriametres 15 hectometres — $6^{Mm}.15$.
— 7 metres 5 centimetres — $7^{m}.05$.
— 18 kilometres 5 metres — $18^{Km}.005$.
— 329 metres 7 centimetres — $329^{m}.07$.
— 6 hectometres 9 metres — $6^{Hm}.09$.
— 3 decimetres 5 millimetres — $3^{dm}.05$.
— 17 millimetres — 17^{mm}.

Exercise 3.

Reduce to metres :

1. $2^{Km}.615$; $17^{Dm}.8$; $3^{Hm}.6$; 215^{dm}; 635^{cm}; 27^{cm}; 5^{cm}; 217^{mm}.

$2^{Km}.615$ or $2{,}615^{m}$.
$17^{Dm}.8$ — 178^{m}.
$3^{Hm}.6$ — 360^{m}.
215^{dm} — $21^{m}.5$.
635^{cm} — $6^{m}.35$.
27^{cm} — $0^{m}.27$.
5^{cm} — $0^{m}.05$.
217^{mm} — $0^{m}.217$.

2. 7^{Mm}; 17^{Km}; 9^{Dm}; 15^{Hm}.

7^{Mm} or $10{,}000^{m} \times 7 = 70{,}000^{m}$.
17^{Km} — $1{,}000^{m} \times 17 = 17{,}000^{m}$.
9^{Dm} — $10^{m} \times 9 = 90^{m}$.
15^{Hm} — $100^{m} \times 15 = 1{,}500^{m}$.

Exercise 4.

Reduce to kilometres :

$3{,}527^{m}$; $745^{Dm}.24$; $495^{Hm}.61$; 43^{m}; $17^{Mm}.25$; 5^{Hm}.

$3{,}527^{m}$. or $3^{Km}.527$.
$745^{Dm}.24$ — $7^{Km}.4524$.
$495^{Hm}.61$ — $49^{Km}.561$.
43^{m} — $0^{Km}.043$.
$17^{Mm}.25$ — $172^{Km}.5$.
5^{Hm} — $0^{Km}.5$.

Exercise 5.

Reduce to decametres :

1. 215^{m}; $43^{Km}.616$; 8^{m}; $78^{Hm}.64$; $9^{Mm}.714$; $4^{Hm}.9$.

215^{m} or $21^{Dm}.5$.
$43^{Km}.616$ — $4{,}361^{Dm}.6$.
8^{m} — $0^{Dm}.8$.
$78^{Hm}.64$ — $786^{Dm}.4$.
$9^{Mm}.714$ — $9{,}714^{Dm}$.
$4^{Hm}.9$ — 49^{Dm}.

2. 13^{Km}; 2^{Hm}; 5^{Mm}; 23^{Hm}.

13^{Km} or $100^{Dm} \times 13 = 1{,}300^{Dm}$.
2^{Hm} — $10^{Dm} \times 2 = 20^{Dm}$.
5^{Mm} — $1{,}000^{Dm} \times 5 = 5{,}000^{Dm}$.
23^{Hm} — $10^{Dm} \times 23 = 230^{Dm}$.

Exercise 6.

Reduce to hectometres :

1. $7{,}395^{m}$; 835^{Dm}; $17^{Km}.645$; $6^{Mm}.724$; 8^{m}.

$7{,}395^{m}$ or $73^{Hm}.95$
835^{Dm} — $83^{Hm}.5$
$17^{Km}.645$ — $176^{Hm}.45$
$6^{Mm}.724$ — $672^{Hm}.4$
8^{m} — $0^{Hm}.08$

2. 4^{Mm}; 23^{Km}.

4^{Mm} or $100^{Hm} \times 4 = 400^{Hm}$
23^{Km} — $10^{Hm} \times 23 = 230^{Hm}$

Exercise 7.

Reduce to centimetres :

$3^{m}.679$; $4^{dm}.07$; $51^{mm}.8$; 9^{mm}; $4^{m}.15$; 3^{m}.

$3^{m}.679$ or $367^{cm}.9$
$4^{dm}.07$ — $40^{cm}.7$
$51^{mm}.8$ — $5^{cm}.18$
9^{mm} — $0^{cm}.9$
$4^{m}.15$ — 415^{cm}
3^{m} — $100^{cm} \times 3 = 300^{cm}$

Exercise 8.

1. How many metres, decametres and hectometres in 3 kilometres?

In 3^{Km}, there are : $3{,}000^{m}$; 300^{Dm}; 30^{Hm}.

2. How many metres, decametres, kilometres and hectometres in $9^{Mm}.7693$?

In $9^{Mm}.7693$, there are : $97{,}693^{m}$; $9{,}769^{Dm}.3$; $97^{Km}.693$; $976^{Hm}.93$.

3. How many centimetres, millimetres and decimetres in 5 metres?

In 5 metres, there are : 500^{cm}; $5{,}000^{mm}$; 50^{dm}.

4. How many decimetres, millimetres and centimetres in $3^{m}.675$?

In $3^{m}.675$, there are : $36^{dm}.75$; $3{,}675^{mm}$; $367^{cm}.5$.

Exercise 9.

1. How many metres in 5 kilometres, 6 hectometres, 3 decametres, 7 metres?

$5^{Km} = 1{,}000^{m} \times 5 = 5{,}000^{m}$
$6^{Hm} = 100^{m} \times 6 = 600^{m}$
$3^{Dm} = 10^{m} \times 3 = 30^{m}$
$7^{m} = 7^{m}$
In all : $5{,}637^{m}$

Or more simply :

$5^{Km} = 5{,}000^{m}$
$6^{Hm} = 600^{m}$
$3^{Dm} = 30^{m}$
$7^{m} = 7^{m}$
In all : $5{,}637^{m}$

2. How many centimetres in 8 metres, 7 decimetres, 9 centimetres?

$8^{m} = 100^{cm} \times 8 = 800^{cm}$
$7^{dm} = 10^{cm} \times 7 = 70^{cm}$
$9^{cm} = 9^{cm}$
In all : 879^{cm}

Or more simply :

$8^{m} = 800^{cm}$
$7^{dm} = 70^{cm}$
$9^{cm} = 9^{cm}$
In all : 879^{cm}

Exercise 10.

1. What is the distance travelled in 57 days by an engine running 7 hours per day at the rate of 7 kilometres 375 metres per hour.

7.375
399
66375
66375
22125
2942.625

The engine runs : $7^{h} \times 57 = 399$ hours; during that time it will travel :

$7^{Km}.375 \times 399 = 2{,}942^{Km}.625$.

Answer : $2{,}942^{Km}.625$.

2. How many steps would a little boy take in walking $6^{Km}.336$ if at every step he goes $0^{m}.375$?

375) 6336000 (16 896
375
2586
2250
.3360
3000
.3600
3375
.2250
2250
....

He will therefore walk :

$$\frac{6{,}336}{0.375} = 16{,}896 \text{ paces.}$$

Answer : 16,896 paces.

3. A carpenter laid planks in three rooms. In the first room, to the length of 52 metres 8 centimetres; in the second, 38 metres 6 decimetres and in the third, 260 decimetres. What is the total length of the wood used?

In the first room the carpenter laid :	$52^{m}.08$
— second.	$38^{m}.6$
— third.	$26^{m}.$
And in all :	$116^{m}.68$

Answer : $116^{m}.68$

4. From a piece of cloth $4^{m}.25$ long, 4 pieces measuring each $0^{m}.27$ are cut. — What is the length of cloth left :

$0^{m}.27 \times 4 = 1^{m}.08$; $4^{m}.25 - 1^{m}.08 = 3^{m}.17$.

Answer : $3^{m}.17$

5. A man walks 53 hectometres per hour at the rate of eight hours per day. How many days will he take to walk a distance of 381 kilometres, 6 hectometres?

$424)\ 3816\ (9$

He walks per day :

53^{Hm} or $5^{Km}.3 \times 8 = 42^{Km}.4$.

He will therefore require to walk :

$$\frac{381.6}{42.4} = 9 \text{ days.}$$

Answer : 9 days.

6. A terrestrial meridian measures $40{,}000{,}000^{m}$ and contains 360^{o}. What is the length of a degree :

(a) in metres; (b) in kilometres ?

$360)\ 40000000\ (111111\frac{1}{9}$

One degree is equal to :

$$\frac{40{,}000{,}000}{360} = 111{,}111^{m}\tfrac{1}{9}$$

or $111^{Km}.111\frac{1}{9}$

Answer : One degree = (a) $111.111^{m}\frac{1}{9}$; (b) $111^{Km}.111\frac{1}{9}$.

CHAPTER III

MEASURES OF SURFACE

The units of surface are squares. A square is a figure having four equal sides and four equal angles.

The principal unit of the measures of surface is the **square metre** (*sqm*).

The square metre is a square measuring *a metre* on each of its sides.

MULTIPLES OF THE SQUARE METRE

The multiples of the square metre are :

The **square deca***metre* (*sqDm*) a square measuring 10^{m} on each of its sides.

The **square hecto***metre* (*sqHm*) a square measuring 100^{m} on each of its sides.

The **square kilo***metre* (*sqKm*) a square measuring 1,000^{m} on each of its sides.

The **square myria***metre* (*sqMm*) a square measuring 10,000^{m} on each of its sides.

SUB-MULTIPLES OF THE SQUARE METRE

The sub-multiples of the square metre are :

The **square deci***metre* (*sqdm*) a square measuring on each of its sides $0^{m}.1$.

The **square centi***metre* (*sqcm*) a square measuring on each of its sides $0^{m}.01$.

The **square milli***metre* (*sqmm*) a square measuring on each of its sides $0^{m}.001$.

VALUE OF THE MEASURES OF SURFACE

The measures of surface are each one hundred times greater or less than the neighbouring sub-multiple or multiple respectively.

Thus the square decimetre equals 100 square centimetres.

For example the square A B C D (see P. 27) measuring on each of its sides one decimetre, is a square *decimetre*.

The side B D is divided into ten equal parts, each division equals 1 centimetre; if for each centimetre we draw a parallel to A B (dotted lines) we obtain ten equal bands.

If we now divide A B into ten equal parts, each also of one centimètre and draw through each point of division a parallel to B D (black lines) we have divided the bands into ten equal parts. Each of these parts is a square and since its four sides measure one centimetre, this is what is called a square centimetre.

As we have ten bands and one band comprises 10 square centimetres, the total amounts to :

$$10^{sqcm} \times 10 = 100 \text{ square centimetres.}$$

The square decimetre is therefore equal to 100 square centimetres.

Similarly for all the measures of surface.

For the multiples :

The **square deca***metre* equals 100 square metres.
The **square hecto***metre* — 100 square decamet.
The **square kilo***metre* — 100 square hectomet.
The **square myria***metre* — 100 square kilomet.

A square decametre being equal to $\mathbf{100}^{\text{sq m}}$.
A square hectometre or $100^{\text{sq Dm}}$ equals :
$100^{\text{sq m}} \times 100 = \mathbf{10{,}000}^{\text{sq m}}$;
A square kilometre or $100^{\text{sq Hm}}$ equals :
$10{,}000^{\text{sq m}} \times 100 = \mathbf{1{,}000{,}000}^{\text{sq m}}$.
A square myriametre or $100^{\text{sq Km}}$ equals :
$1{,}000{,}000^{\text{sq m}} \times 100 = \mathbf{100{,}000{,}000}^{\text{sq m}}$.

For the sub-multiples :

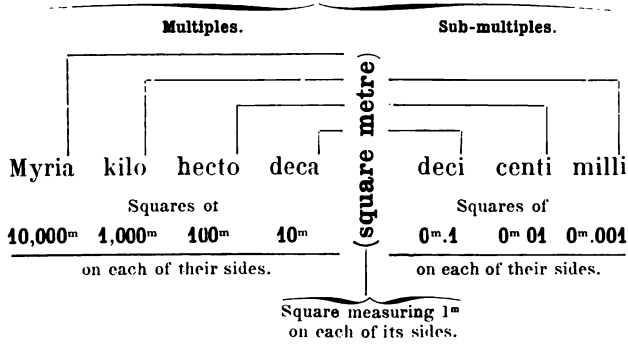
The **square deci***metre* is the *hundredth* part of the square metre.
The **square centi***metre* is the *hundredth* part of the square decimetre.
The **square milli***metre* is the *hundredth* part of the square centimetre.

Or again there are :

100 square decimetres in 1 square metre.
100 square centimetres in 1 square decimetre.
100 square millimetres in 1 square centimetre.

Remark.—One square metre equals $100^{\text{sq dm}}$ or $10{,}000^{\text{sq cm}}$ or $1{,}000{,}000^{\text{sq mm}}$.
One square decimetre equals $100^{\text{sq cm}}$ or $10{,}000^{\text{sq mm}}$.
One square centimetre equals $100^{\text{sq mm}}$.

RECAPITULATORY TABLE OF THE UNITS OF SURFACE



TO READ A NUMBER REPRESENTING A SURFACE

To read a number representing a surface, first read the whole part, to which is given the name of the principal unit, then the decimal part, dividing the latter into sets of two figures beginning from the decimal point and going towards to the right. Read each set separately giving it the name of the unit it represents.

Examples :

1. Read $15^{sqm}.0423$.

Dividing the decimal part into sets of two figures, we have :

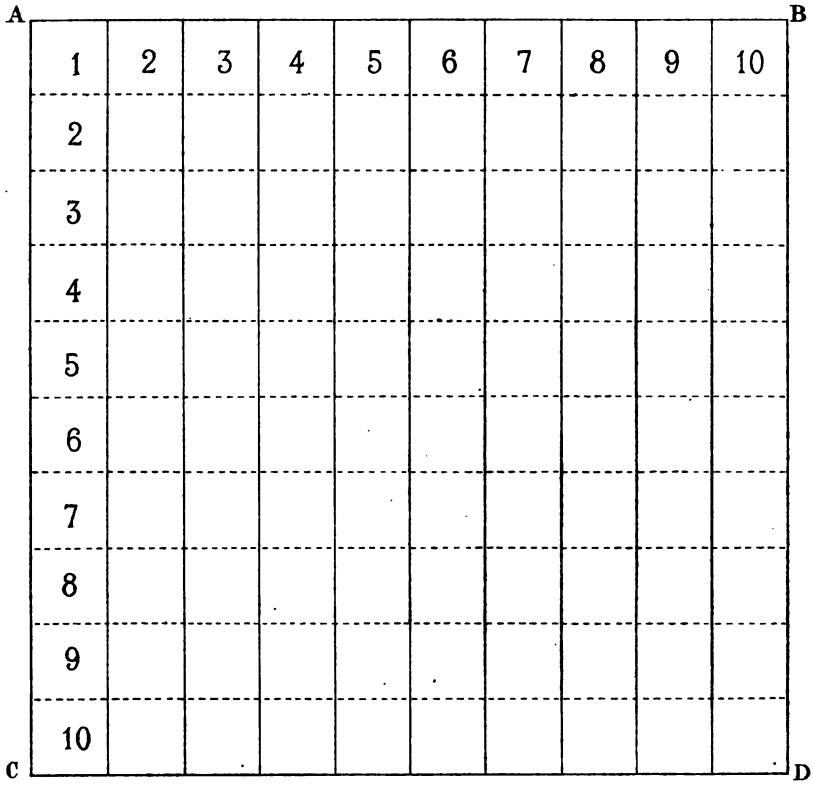
$$15^{sqm} \mid 04^{sqdm} \mid 23^{sqcm}$$

and we read :

fifteen square metres, four square decimetres, twenty three square centimetres.

Remark.—For all the exercises, the pupil must study the recapitulatory table of the units of surface,

Square centimetre



Square decimetre

exact size

divided in 100 square centimetres

so as to remember the order in which these units follow and that two figures are needed to represent each unit.

2. If a decimal unit is only represented by one figure add a nought, mentally.

Read the number $13^{sqm}.17892$.

Dividing the decimal part into sets of two figures, we have :

$$13^{sqm} \mid 17 \mid 89 \mid 2$$

and we read :

Thirteen square metres, seventeen square decimetres, eighty-nine square centimetres, twenty square millimetres.

3. $0^{sqm}.145876$

is read :

0 square metres 14 square decimetres 58 square centimetres 76 square millimetres.

4. For $35^{sqDm}.83$

read :

35 square decametres 83 square metres.

TO WRITE A NUMBER REPRESENTING A SURFACE

To write a number representing a surface write first the principal units; then place the decimal point, and afterwards the decimal units, which must each have two figures.

Examples :

1. 875 square metres 75 square decimetres 43 square centimetres 17 square millimetres are written :

$$875^{sqm}.754317.$$

2. 43 square metres 7 square decimetres 5 square centimetres are written :

$$43^{sqm}.0705.$$

As two figures are needed for each unit of surface a nought (**0**) is placed before the square decimetres which have only one figure, and similarly the (**0**) for the square centimetres.

3. 48 square metres 17 square centimetres 22 square millimetres are written :

$$48^{sqm}.001722.$$

Since the square decimetres are missing entirely they are represented by the two noughts (**00**).

4. 0 square metres 17 square decimetres 25 square centimetres are written :

$$0^{sqm}.1725.$$

The nought (**0**) takes the place of the principal units.

5. 84 square kilometres 25 square decametres are written :

$$84^{sqKm}.0025.$$

CHANGING THE UNIT

We may have to convert a number expressing surface into units of another order.

Notice.—*First :* That each unit of surface is represented by a set of two figures.

Secondly : That the units of surface succeed one another from right to left, from the lowest to the highest as shown in the recapitulatory table of surfaces.

Knowing therefore the place occupied by each set, the rule for changing a unit is the following :

Rule.—Carry the decimal point to the right of the required unit two, four or six places to the right or the left.

Examples :

1. Reduce to *square metres :*

$873^{sqdm}.4976.$

By separating the number into sets of two figures beginning from the decimal point, we get :

$8^{sqm} \mid 73^{sqdm} \mid 49^{sqcm} \mid 76^{sqmm}.$

Since the square metres occupy the first set to the left hand of the square decimetres, the decimal point is therefore displaced two rows to the left and this gives :

$8^{sqm}.734\,976.$

2. Convert $83,769^{sqm}$ into *square decametres.*

By separating the number into sets of two figures beginning, from the right, we get :

$8^{sqHm} \mid 37^{sqDm} \mid 69^{sqm}.$

Since the square decametres occupy the first set to the left hand of the square metres, the decimal point is placed after 37 and this gives :

$837^{sqDm}.69.$

3. Convert into *square metres* $9^{sqHm}.3756$.

By dividing the number into sets of two figures each, beginning from the decimal point we get :

$$9^{sqHm} \mid 37^{sqDm} \mid 56^{sqm}.$$

To the right of the square hectometres are two sets, the first representing the square decametres and the other the square metres, the point is then carried four rows to the right which gives :

$$93,756^{sqm}.$$

When the principal units are not expressed they are replaced by a nought.

4. Reduce 35^{sqm} to *square decametres.*

The square decametres should be found immediately to the left of the square metres, but as they do not exist, they are replaced by a nought (**0**) and the result is :

$$\mathbf{0}^{sqDm}.35.$$

5. Change 7^{sqm} to *square centimetres.*

Result : $70,000^{sqcm}$.

The square centimetres should occupy the place of the second set on the right of the square metres but since neither they nor the square decimetres are expressed we must add four noughts, that is to say, two noughts for each set not expressed.

CHOICE OF A UNIT OF SURFACE

Square metres are used to express the surface of a wall, or of a yard.

For smaller surfaces the square decimetre is chosen as unit. The surface of a tile or of a sheet of paper is given in square decimetres.

The square metre, the square decametre and the square hectometre are taken as units for measuring fields. (Refer to the land measures.)

And lastly the area of a country is expressed in square kilometres, the latter are then termed topographical measures.

For instance Great Britain measures 315,000^{sqKm}.
— France — 529,000^{sqKm}.

Remark.—The measures of surface are obtained by calculations.

The surface of a wall, or of a sheet of paper is found by reckoning and not by applying repeatedly to a surface either a square metre or a square decimetre.

EXERCISES ON THE MEASURES OF SURFACE

Exercise 1.

To read numbers expressing surfaces.

For 4^{sqm}.36, read : 4 square metres 36 square decimetres.
— 124^{sqm}.06 — 124 square metres 6 square decimetres.
— 6^{sqDm}.25 — 6 square decametres 25 square metres.
— 9^{sqdm}.47 — 9 square decimetres 47 square centimetres.
— 0^{sqm}.83 — 0 square metres 83 square decimetres.
— 15^{sqm}.9 — 15 square metres 90 square decimetres.
— 0^{sqm}.05 — 0 square metres 5 square decimetres.
— 135^{sqHm}.18 — 135 square hectometres 18 square decametres.
— 73^{sqcm}.9 — 73 square centimetres 90 square millimetres.
— 15^{sqKm}.64 — 15 square kilometres 64 square hectometres.
— 0^{sqm}.845 — 0 sq. metres 84 sq. decim. 50 sq. centim.
— 8^{sqKm}.640065 — 8 sq. kilom. 64 sq. hect. 65 sq. met.
— 0^{sqm}.0018 — 0 sq. metres 18 sq. centimetres.

Exercise 2.

To write numbers expressing surfaces.

For 7 square metres 15 square decimetres, write : $7^{sqm}.15$.
— 14 square decametres 9 square metres — $14^{sqDm}.09$.
— 9 square kilometres 17 square metres — $9^{sqKm}.000017$.
— 8 square decametres 5 square decimetres — $8^{sqDm}.0005$.
— 19 square metres 27 square centimetres — $19^{sqm}.0027$.
— 143 square hectometres 19 square metres — $143^{sqHm}.0019$.
— 8 square metres 25 square millimetres — $8^{sqm}.000025$.
— 7 square kilometres 8 square decametres — $7^{sqKm}.0008$.
— 6 sq. decim. 17 sq. centim. 8 sq. millim. — $6^{sqdm}.1708$.
— 15 sq. hectom. 24 sq. decam. 35 sq. metres — $15^{sqHm}.2435$.

Exercise 3.

Reduce to square metres the following :

1. $273^{sqDm}.64$; $8^{sqHm}.67947$; 835^{sqcm}; $4^{sqKm}.8756$; $8,737^{sqdm}$; 94^{sqdm}.

$273^{sqDm}.64 = 27,364^{sqm}$.
$8^{sqHm}.67947 = 86,794^{sqm}.7$.
$835^{sqcm} = 0^{sqm}.0835$.
$4^{sqKm}.8756 = 4,875,600^{sqm}$.
$8,737^{sqdm} = 87^{sqm}.37$.
$94^{sqdm} = 0^{sqm}.94$.

2. 8^{sqDm}; 67^{sqHm}; 25^{sqKm}; 19^{sqMm}.

8^{sqDm} or $100^{sqm} \times 8 = 800^{sqm}$.
67^{sqHm} — $10,000^{sqm} \times 67 = 670,000^{sqm}$.
25^{sqKm} — $1,000,000^{sqm} \times 25 = 25,000,000^{sqm}$.
19^{sqMm} — $100,000,000^{sqm} \times 19 = 1,900,000,000^{sqm}$.

Exercise 4.

Reduce to square hectometres the following :

$169,387^{sqm}$; $873^{sqDm}.64$; $24^{sqKm}.7789$; $17^{sqKm}7$; 43^{sqDm}; 725^{sqm}.

$169,387^{sqm} = 16^{sqHm}.9387$.
$873^{sqDm}.64 = 8^{sqHm}.7364$.
$24^{sqKm}.7789 = 2,477^{sqHm}.89$.
$17^{sqKm}.7 = 1,770^{sqHm}$.
$43^{sqDm} = 0^{sqHm}.43$.
$725^{sqm} = 0^{sqHm}.0725$.

Exercise 5.

Reduce to square decimetres the following :

1. $724^{sqm}.637$; $237^{sqcm}.39$; 13^{sqcm}; $62{,}847^{sqmm}$; $8^{sqDm}.76$; 19^{sqmm}.

$724^{sqm}.637 = 72{,}463^{sqdm}.7.$
$237^{sqcm}.39 = 2^{sqdm}.3739.$
$13^{sqcm} = 0^{sqdm}.13.$
$62{,}847^{sqmm} = 6^{sqdm}.2847.$
$8^{sqDm}.76 = 87{,}600^{sqdm}.$
$19^{sqmm} = 0^{sqdm}.0019.$

2. 34^{sqm}; 618^{sqDm}.

34^{sqm} or $100^{sqdm} \times 34 = 3{,}400^{sqdm}.$
618^{sqDm} — $10{,}000^{sqdm} \times 618 = 6{,}180{,}000^{sqdm}.$

Exercise 6.

Reduce to square decametres the following :

1. $1{,}273^{sqm}$; $27^{sqHm}.614$; $15^{sqKm}.74295$; 95^{sqm}; $72^{sqHm}.9$; $13^{sqKm}.64$.

$1{,}273^{sqm} = 12^{sqDm}.73.$
$27^{sqHm}.614 = 2{,}761^{sqDm}.4.$
$15^{sqKm}.74295 = 157{,}429^{sqDm}.5.$
$95^{sqm} = 0^{sqDm}.95.$
$72^{sqHm}.9 = 7{,}290^{sqDm}.$
$13^{sqKm}.64 = 136{,}400^{sqDm}.$

2. 539^{sqKm}; 273^{sqHm}.

539^{sqKm} or $10{,}000^{sqDm} \times 539 = 5{,}390{,}000^{sqDm}.$
273^{sqHm} — $100^{sqDm} \times 273 = 27{,}300^{sqDm}.$

Exercise 7.

1. How many square metres and square decametres in 8 square hectometres?

In 8^{sqHm}, there are : 80.000^{sqm}; 800^{sqDm}.

2. How many square decametres and square metres in $4^{sqHm}.876$?

In $4^{sqHm}.876$, there are : $487^{sqDm}.6$; 48.760^{sqm}.

3. How many square decimetres and square centimetres, square millimetres in 6 square metres?

In 6^{sqm}, there are : 600^{sqdm}; $60,000^{sqcm}$; $6,000,000^{sqmm}$.

4. How many square centimetres and square decimetres in $3^{sqm}.78$?

In $3^{sqm}.78$, there are : $37,800^{sqcm}$; 378^{sqdm}.

Exercise 8.

1. Add :

$8^{sqm}.10 + 7^{sqDm}.9623 + 20^{sqDm}.6874 + 3^{sqHm}.430350.$

$8^{sqm}.10$	=	$8^{sqm}.10$
$7^{sqDm}.9623$	=	$796^{sqm}.23$
$20^{sqDm}.6874$	=	$2,068^{sqm}.74$
$3^{sqHm}.430350$	=	$34,303^{sqm}.50$
	In all :	$37,176^{sqm}.57$

2. A paved yard measures $19^{m}.70$ by $7^{m}.20$, what is its surface?

19.7
7.2
394
1379
141.84

The yard has the shape of a rectangle. Its surface is :

$19.70 \times 7.20 = 141^{sqm}.84.$

Answer : $141^{sqm}.84$.

3. A farmer has a field measuring $137^{sqDm}.2140$ and keeps for himself a portion of $920^{sqm}.16$. The remainder is sold in lots of $711^{sqm}.18$. How many lots has he been able to make?

13,721.40
920.16
12,801.24

If from this field of $137^{sqDm}.2140$ or $13,721^{sqm}.40$ the farmer keeps : $920^{sqm}.16$;

there remains :

$13,721^{sqm}.40 - 920^{sqm}.16 = 12,801^{sqm}.24$

71118) 1280124 (18
71118
.568944
568944
.....

which can be divided into :

$\frac{12,801.24}{711.18} = 18$ lots.

Answer : 18 lots.

4. The walls of a square room have each a surface measuring $17^{sqm}.20$. What is the surface to be painted, if there are two windows having each eight panes of glass $12^{sqdm}.60$ surface each pane?

12.60
16
7560
1260
201.60

The two windows have $8 \times 2 = 16$ panes of glass having a surface of :

$12^{sqdm}.60 \times 16 = 201^{sqdm}.60$ or $2^{sqm}.016$.

The surface of the walls of the room is :

$17^{sqm}.20 \times 4 = 68^{sqm}.80$.

68.80
2.016
66.784

There remains to be painted :

$68^{sqm}.80 - 2^{sqm}.016 = 66^{sqm}.784$.

Answer : $66^{sqm}.784$.

5. A house contains three bedrooms, a kitchen and a parlour. The first bedroom measures in surface $13^{sqm}.975$, the second $22^{sqm}.40$, the third $26^{sqm}.60$, the kitchen $9^{sqm}.5$ and the parlour $4^{sqm}.50$.

What is the total surface of all the rooms?

13.975
22.40
26.60
9.50
4.50
76.975

The rooms have altogether a surface of :

$13^{sqm}.975 + 22^{sqm}.40 + 26^{sqm}.60 + 9^{sqm}.5 + 4^{sqm}.50 = 76^{sqm}.975.$

Answer : $76^{sqm}.975$.

6. A rectangular passage measures $6^{m}.50$ long by $1^{m}.95$ wide, how many flags will be required to cover its surface, supposing each flag to measure 50 centimetres by 13 centimetres?

50 | 6.50
13 | 1.95
150 | 3250
50 | 5850
650 | 650
12,6750

The surface of the passage is equal to :

$6.50 \times 1.95 = 12^{sqm}.6750$

A flag measures :

$50 \times 13 = 650^{sqcm}$ or $0^{sqm}.065$.

65) 12675 (195
65
.617
585
.325
325
...

There will be needed :

$$\frac{12.675}{0.065} = 195 \text{ flags.}$$

Answer : 195 flags.

7. What will be the surface covered by 480 tiles if each tile measures 4 square decimetres 25 square centimetres?

4.25
480
34000
1700
2040.00

The 480 tiles measure a surface of :

$4^{sqdm}.25 \times 480 = 2040^{sqdm}$

or $20^{sqm}.40$

Answer : $20^{sqm}.40$.

8. A garden has a superficies of 175 square metres 55 square decimetres. Two paths are traced; one of 12 square metres 4 square decimetres, the

other of 8 square metres 15 square decimetres. What portion remains to be cultivated?

		The two paths occupy a surface of:
12.04	175.55	$12^{sqm}.04 + 8^{sqm}.15 = 20^{sqm}.19$.
8.15	20.19	There remains to be cultivated :
20.19	155.36	$175^{sqm}.55 - 20^{sqm}.19 = 155^{sqm}.36$.

Answer : $155^{sqm}.36$.

Measures of land

The principal unit of land measure is the **are** (*a*)[1].

The are is equal to a square decametre.

It has a multiple the **hectare** (*Ha*) which equals **100** ares.

The hectare is equal to the *square hectometre*.

The sub-multiple of the are is the **centiare** (*ca*) which is equal to the *square metre*.

The centiare is the *hundredth* part of the *are*.

RECAPITULATORY TABLE OF THE MEASURES OF LAND

Mutiple		Sub-multiple
Hectare.	are	centiare.
100	1	0.01 or $\frac{1}{100}$

The hectare equals 100 ares or $10{,}000^{ca}$ or $10{,}000^{sqm}$.
The are . . . . . 100^{ca} — 100^{sqm}.
The centiare . . . . . 1^{sqm}.

1. ARE from the Latin *area*.

TO READ AND WRITE A NUMBER REPRESENTING ARES

To read and write a number representing ares the same rule as that for reading and writing measures of surface is applied.

Examples :

1. 33 ^{a}. 54.
   Read : *thirty three ares fifty four centiares.*

2. 1,243 ^{Ha}. 17 3.
   Read : 1,243 hectares 17 ares 30 centiares.

3. 4 ^{a}. 07 read : 4 ares 7 centiares.
   0 ^{a}. 84 — 0 ares 84 centiares.

4. 83 ares 17 centiares is written :
   83 ^{a}. 17.

5. 4 hectares 8 ares 25 centiares.
   Write : 4 ^{Ha}. 0825.

   A nought (**0**) is added because two figures are needed to write the ares and there is only one figure.

6. 9 hectares 24 centiares.
   Write thus : 9 ^{Ha}. 0024.

   Here two noughts (**00**) replace the ares which are not expressed.

7. And lastly 0 ares 24 centiares are written :
   0^{a}.24.

CHANGING THE UNIT

A number representing ares can also be made to express hectares or centiares. The same rule is followed as that given for changing the units of the measures of surface, bearing well in mind the recapitulatory table of land measures.

Examples :

1. Convert $804^{a}.30$ into *hectares.*

Separate the number into sets of two figures beginning from the decimal point :

$$8^{Ha} \mid 04^{a} \mid 30^{ca}$$

and the hectares coming immediately to the left of the ares, the decimal point is carried to the right hand of the required units and you obtain

$$8^{Ha}.0430.$$

2. Reduce $2^{Ha}.075$ to *ares* and *centiares.*

In ares, we get : $207^{a}.50$.
In centiares, — 20,750 centiares.

A number expressing hectares, ares and centiares can easily be written in units of surface.

As many centiares, so many square metres.
As many ares, so many square decametres.
As many hectares, so many square hectometres.

Thus : $2{,}473^{ca}$ make $2{,}473^{sqm}$.
$84^{a}.25$ make $84^{sqDm}.25$ or $8{,}425^{sqm}$.
$33^{Ha}.2672$ make $33^{sqHm}.2672$ or $33{,}2672^{sqm}$.

The converse operation is equally simple.

As for example, $47,897^{sqm}$.

By separating the number into sets of two figures, beginning from the right, we get :

$$4^{sqHm}. \mid 78^{sqDm}. \mid 97^{sqm}.$$

or

$$4^{Ha}. \mid 78^{a}. \mid 97^{ca}.$$

Therefore in $47,897^{sqm}$, there are :

$$4^{Ha}.78^{a}.97^{ca}.$$

EXERCISES ON LAND MEASURES

Exercise 1.

Reading numbers expressing land measures :

For	$45^{a}.75$,	read :	45 ares 75 centiares.
—	$5^{Ha}.8730$,	—	5 hectares 87 ares 30 centiares.
—	217^{ca},	—	217 centiares.
—	15^{Ha},	—	15 hectares.
—	$24^{Ha}.006$,	—	24 hectares 60 centiares.
—	$218^{a}.7$,	—	218 ares 70 centiares.
—	$0^{a}.74$,	—	0 ares 74 centiares.
—	519^{a}.	—	519 ares.

Exercise 2.

Writing numbers expressing land measures :

13 ares 24 centiares	are written :	$13^{a}.24$.
18 hectares 17 ares 34 centiares	—	$18^{Ha}.1734$.
5 hectares 2 ares	—	$5^{Ha}.02$.
72 hectares 14 centiares	—	$72^{Ha}.0014$.
3 ares 6 centiares	—	$3^{a}.06$.
9 hectares 2 centiares	—	$9^{Ha}.0002$.

Exercise 3.

Convert into centiares the following numbers :

1. $14^{a}.6$; $78^{a}.986$; $8^{Ha}.9075$; $7^{Ha}.935$.

$14^{a}.6$ or $1,460^{ca}$.
$78^{a}.986$ — $7,898^{ca}.6$.
$8^{Ha}.9075$ — $89,075^{ca}$.
$7^{Ha}.635$ — $76,350^{ca}$.

2. 3^{Ha}; 16^{a}.

3^{Ha} or $10,000^{ca} \times 3 = 30,000^{ca}$.
16^{a} — $100^{ca} \times 16 = 1,600^{ca}$.

3. $63^{sqm}.07$; 5^{sqm}; $17^{sqDm}.675$; $3^{sqHm}.74$.

$63^{sqm}.07$ or $63^{ca}.07$.
5^{sqm} — 5^{ca}.
$17^{sqDm}.675$ or $1,767^{sqm}.5$ or $1,767^{ca}.5$
$3^{sqHm}.74$ — $37,400^{sqm}$. — $37,400^{ca}$.

Exercise 4.

Convert into ares the following numbers :

1. $63^{Ha}.605$; $17,097^{ca}$; $2^{Ha}.5$; 8^{ca}; $0^{Ha}.64$; 15^{Ha}.

$63^{Ha}.605 = 6,360^{a}.5$.
$17,097^{ca} = 170^{a}.97$.
$2^{Ha}.5 = 250^{a}$.
$8^{ca} = 0^{a}.08$.
$0^{Ha}.64 = 64^{a}$.
$15^{Ha} = 100^{a} \times 15 = 1,500^{a}$.

2. $13^{sqDm}.675$; $637^{sqHm}.6$; $609^{sqm}.67$; $17^{sqm}.5$.

$13^{sqDm}.675 = 13^{a}.675$.
$637^{sqHm}.6 = 63,760^{sqDm}$ or $63,760^{a}$.
$609^{sqm}.67 = 6^{sqDm}.0967$ — $6^{a}.0967$.
$17^{sqm}.5 = 0^{sqDm}.175$ — $0^{a}.175$.

Exercise 5.

Reduce the following numbers to hectares :

1. $798^{a}.35$; $21{,}567^{ca}$; 83^{a}; 615^{ca}.

$798^{a}.35 = 7^{Ha}.9835.$
$21{,}567^{ca} = 2^{Ha}.1567.$
$83^{a} = 0^{Ha}.83.$
$615^{ca} = 0^{Ha}.0615.$

2. $65^{sqHm}.02$; 97.876^{sqm}; 753^{sqDm}; 19^{sqKm}.

$65^{sqHm}.02 = 65^{Ha}.02$
97.876^{sqm} or $9^{sqHm}.7876 = 9^{Ha}.7876$
753^{sqDm} — $7^{sqHm}.53 = 7^{Ha}.53$
19^{sqKm} — $1{,}900^{sqHm} = 1{,}900^{Ha}$

Exercise 6.

1. How many ares and centiares in 9 hectares?

In 9^{Ha}, there are : 900^{a}; $90{,}000^{ca}$.

2. How many centiares and ares in $4^{Ha}.075$?

In $4^{Ha}.075$, there are : $40{,}750^{ca}$; $407^{a}.5$.

3. How many ares and centiares in 17^{sqHm}?

In 17^{sqHm}, there are : $1{,}700^{a}$; $170{,}000^{ca}$.

4. How many centiares and ares in $8^{sqHm}.205$?

In $8^{sqHm}.205$, there are : $82{,}050^{ca}$; $820^{a}.5$.

5. How many square hectometres, square decametres and square metres in 6 hectares?

In 6^{Ha}, there are : 6^{sqHm}; 600^{sqDm}; $60{,}000^{sqm}$.

6. How many square metres, square decametres and square hectometres in $3^{Ha}.097$?

In $3^{Ha}.097$, there are : $30{,}970^{sqm}$; $309^{sqDm}.7$; $3^{sqHm}.097$.

Exercise 7.

1. A farmer owns land which is sown as follows : 123 ares 15 centiares in wheat, 1 hectare 60 ares in oats and 6,794 centiares in rye. What is : first, in centiares; secondly, in ares and thirdly, in hectares, the superficies of his land?

In wheat : $123^{a}.15$ or $12{,}315^{ca}$
In oats : $1^{Ha}.60$ — $16{,}000$
In rye : 6794^{ca} — $6{,}794$
$35{,}109$

Answer : The land has a superficies of :

$35{,}109^{ca}$
or $351^{a}.09$
or $3^{Ha}.5109$

2. The total surface of land owned by a farmer is 3 hectares 90 ares 18 centiares. If the farmer sells his land in lots of 65 ares 3 centiares each, how many lots can he make?

6503) 39018 Each lot is : $65^{a}03$ or $6{,}503^{ca}$
6 The total surface $= 3^{Ha}.9018$ or $39{,}018^{ca}$

He will therefore make : $\frac{39018}{6503} = 6$ lots.

Answer : 6 lots.

3. The area of the British Islands is 315,000 square kilometres and that of France 529,000 square kilometres. Give in hectares the difference in area between the two countries?

The area of France is :
$529{,}000^{qKm}$ or $52{,}900{,}000^{qHm}$ or $52{,}900{,}000^{Ha}$
The area of British Islands is :
$315{,}000^{qKm}$ or $31{,}500{,}000^{qHm}$ or $31{,}500{,}000^{Ha}$
The difference is : $21{,}400{,}000^{Ha}$

Answer : $21{,}400{,}000^{Ha}$

4. A rectangular field measures 84^{m} by 172^{m}. Wha is its superficies in hectares, ares and centiares?

$$\begin{array}{r} 84 \\ 172 \\ \hline 168 \\ 588 \\ 84 \\ \hline 14448 \end{array}$$

Surface of the field =
$84 \times 172 = 14448^{sq\,m}$ or 14448^{ca},
or $1^{Ha}\ 44^{a}\ 48^{ca}$.

Answer : $1^{Ha}\ 44^{a}\ 48^{ca}$.

5. From a field measuring $3^{Ha}.7^{a}$ is sold 39^{a}. What remains?

$$\begin{array}{r} 307 \\ 39 \\ \hline 268 \end{array}$$

In $3^{Ha}.7^{a}$, there are : 307 ares; there remain therefore :

$307^{a} - 39^{a} = 268$ ares.

Answer : 268 ares.

CHAPTER IV

MEASURES OF VOLUME

The volume of a body is the place it occupies in space.

The units of volume are called *cubes*.

A cube is a body limited by six equal squares.

Dice are cubes.

The principal unit of the measures of volume is the **cubic metre** (*cm.*); it is a cube the edges of which measure one metre.

Each of its faces measures one square metre.

MULTIPLES AND SUB-MULTIPLES OF THE CUBIC METRE.

The multiples of the cubic metre have not any special names. We say ten, twenty, thirty, two hundred or ten thousand cubic metres.

The sub-multiples of the cubic metre are :

The **cubic deci***metre* (*cdm*) cube having a side of 1^{dm}
The **cubic centi***metre* (*ccm*) — — 1^{cm}
The **cubic milli***metre* (*cmm*) — — 1^{mm}

The cubic decimetre is equal to 1,000 cubic centimetres. Consider the cubic decimetre *a. b. c. d. e. f. g. h.;* it has an edge of one decimetre (*see sketch at side*).

Its faces measure each one square decimetre or one hundred square centimetres.

We can divide the face *e, f, g, h,* into 100 square centimetres. On each of these square centimetres, we lay one cubic centimetre (a cube having an edge of one centimetre) and the result is a collection of 100 cubic centimetres.

As a vertical edge gd., for example, measures 1^{dm} or 10 centimetres; we can place one above the other 10 cubic centimetres or 10 collections of cubic centimetres similar to the one placed on *e, f, g, h,* we therefore obtain altogether : 10 times 100 cubic centimetres or 1,000 cubic centimetres. **The cubic decimetre is therefore equal to 1,000 cubic centimetres.**

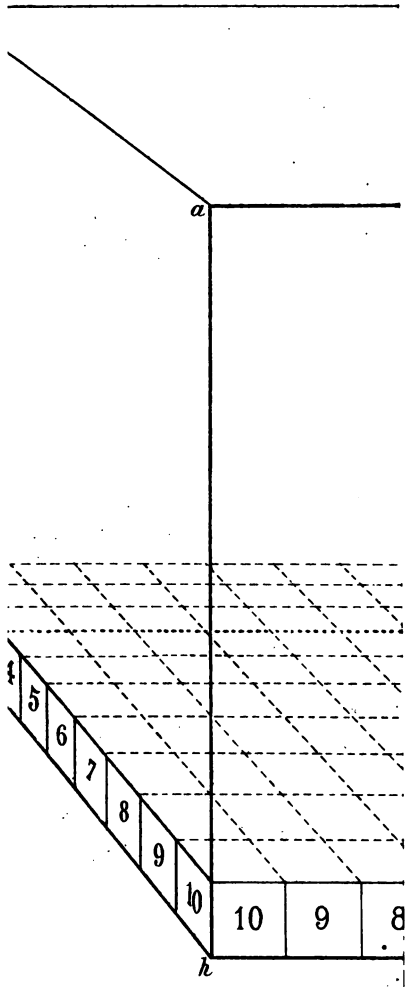
The same method holds good for all the units of volume :

The cubic metre is equal to 1,000 cubic decimetres.
The cubic decimetre is equal to 1,000 cubic centimetres.
The cubic centimetre is equal to 1,000 cubic millimetres.

It is therefore easily observed that :

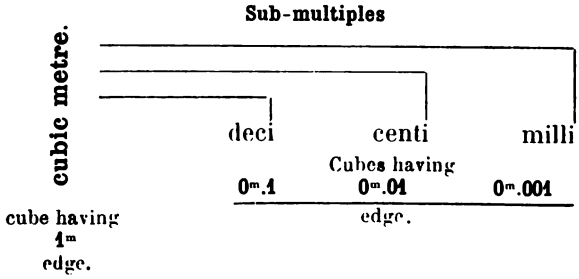
The cubic metre contains $1{,}000^{cdm}$ or $1{,}000{,}000^{ccm}$ or $1{,}000{,}000\,000^{cmm}$;
The cubic decimetre, $1{,}000^{ccm}$ or $1{,}000{,}000^{cmm}$;
The cubic centimetre, $1{,}000^{cmm}$.

Cubic c



Cubi

RECAPITULATORY TABLE OF THE MEASURES OF VOLUME



TO READ A NUMBER EXPRESSING A VOLUME

To read a number expressing volume we read first the whole part, to which is given the name of the principal unit; then the decimal units, dividing the latter into sets of three figures, beginning from the decimal point and going to wards the right; lastly we read separately each set, giving it the name of the units it represents.

Examples :

1. Read $8^{cm}.037142$.

By separating the decimal part into sets of three figures, beginning from the decimal point, we get :

$$8^{cm} \mid 037^{cdm} \mid 142^{ccm}.$$

Which we read : *Eight cubic metres, thirty seven cubic decimetres, one hundred and forty two cubic centimetres.*

2. If one of the sets spoken of above is incomplete, add mentally 1 or 2 noughts.

Read $25^{cm}.4327$.

By separating the decimal part into sets of three figures beginning from the decimal point, we get :

$25^{cm}.$ | 432 | 7,

and we read :

25 cubic metres 432 cubic decimetres 700 cubic centimetres.

3. $0^{cm}.00574324$

read :

0 cubic metres 5 cubic decimetres 743 cubic centimetres 240 cubic millimetres;

4. and $13^{cdm}.615$

read :

13 cubic decimetres 615 cubic centimetres.

TO WRITE A NUMBER EXPRESSING VOLUME

To write a number expressing volume, write first the principal units, then the decimal point, afterwards the decimal units; the latter must have each three figures.

Examples :

1. 43 cubic metres 237 cubic decimetres 149 cubic centimetres are written :

$43^{cm}.237149.$

2. 82 cubic metres 5 cubic decimetres 15 cubic centimetres are written :

$$82^{cm}\cdot\mathbf{005\,015}$$

As three figures are needed for each unit of volume two noughts (**00**) are placed before the cubic decimetres and one nought (**0**) to the cubic centimetres.

3. 18 cubic metres 239 cubic centimetres are written :

$$18^{cm}.\mathbf{000\,239}$$

Since the cubic decimetres missing are they must be replaced by three noughts (**000**).

And lastly : 217 cubic decimetres 45 cubic centimetres is written :

$$217^{cdm}.\mathbf{045}$$

CHANGING THE UNIT

To convert a number representing volume into units of another order, it is important to remember :

First, that for each unit of volume a set of three figures is needed.

Secondly, that the units of volume succeed one another from right to left, and from the least to the greatest in the order set forth in the recapitulatory table of measures of volume.

The following rule is applied for changing a unit of volume.

RULE.—To convert a number expressing volume into units of another order, carry the de-

cimal point to the right of the required units 3, 6 or 9 places either to the right or the left.

Examples :

1. Convert $3^{cm}.45367$ into *cubic decimetres.*

By separating the decimal part into sets of three figures each, beginning from the decimal point, we get :

$$3^{cm}. \mid 453^{cdm}. \mid 670^{ccm}.$$

Since the cubic decimetres occupy the first set to the right after the metres, carry the decimal point three rows of figures to the right to obtain :

$$3,453^{cdm}.670.$$

2. Reduce $2^{cm}.76343584$ to *cubic centimetres.*

By separating the decimal part into sets of three figures, beginning from the decimal point we get :

$$2^{cm} \mid 763^{cdm} \mid 435^{ccm} \mid 840^{cmm}$$

The cubic centimetres being placed in the second set to the right after the metres, carry the decimal point six rows of figures to the right to obtain :

$$2,763,435^{ccm}.840$$

3. Convert into *cubic metres* 47,368 cubic decimetres.

By separating the number into sets of three figures each, beginning from the right, we get :

$$47^{cm} \mid 368^{cdm}$$

The cubic metres coming immediately to the left of the cubic decimetres, carry the decimal to the right of 47, three places to the left to get :

$$47^{cm}.368$$

4. Reduce 75 cubic decimetres to *cubic metres.*

As we have less than three figures, no cubic metres are therefore expressed, replace them by a nought (**0**) and the number asked for is :

$$0^{cm}.075$$

5. Reduce 24^{cm} to *cubic decimetres*.

As 1 cubic metre equals 1,000 cubic decimetres, in 24 cubic metres there are :

$$1{,}000^{cdm} \times 24 = 24{,}000^{cdm}.$$

Remark.—The measures of volume are similar to the measures of surface inasmuch as neither are in tangible existence.

We obtain the volume of a body by calculating how many times it can contain cubic metres and cubic decimetres.

EXERCISES ON THE MEASURES OF VOLUME

Exercise 1.

To read numbers expressing volumes.

For $613^{cm}.430$,	read: 613 cubic metres 430 cubic decimetres.
— $217^{cm}.025$,	— 217 cubic metres 25 cubic decimetres.
— $17^{ccm}.074$,	— 17 cubic centimetres 74 cubic millimetres.
— $2^{cm}.035\,000\,008$,	— 2 cubic metres 35 cubic decimetres 8 cubic millimetres.
— $17^{cdm}.104\,029$,	— 17 cubic decimetres 104 cubic centimetres 29 cubic millimetres.
— $7^{cm}.000\,53$,	— 7 cubic metres 530 cubic centimetres.
— $3^{cdm}.4$,	— 3 cubic decimetres 400 cubic centimetres.
— $43^{cdm}.610$,	— 43 cubic decimetres 610 cubic centimetres.
— $9^{cdm}.153$,	— 9 cubic decimetres 153 cubic centimetres.
— $0^{cm}.003$,	— 0 cubic metres 3 cubic decimetres.

Exercise 2.

To write numbers expressing volume.

For 230 cubic metres 107 cubic decimetres,
write : $230^{cm}.107$.

— 15 cubic metres 324 cubic centimetres,
write : $15^{cm}.000324$.

— 29 cubic metres 17 cubic decimetres 8 cubic centimetres,
write : $29^{cm}017008$.

— 3 cubic metres 15 cubic decimetres 117 cubic millimetres,
write : $3^{cm}015000117$.

— 7 cubic decimetres 24 cubic centimetres,
write : $7^{cdm}.024$.

— 13 cubic centimetres 5 cubic millimetres,
write : $13^{ccm}.005$.

Exercise 3.

Reduce to cubic metres : $21,678^{cdm}$; $2,073,946^{ccm}$; 74^{cdm}; $2,196^{ccm}$; 9^{cdm}; 795^{ccm}.

$21,678^{cdm} = 21^{cm}.678$
$2,073,946^{ccm} = 2^{cm}.073\,946.$
$74^{cdm} = 0^{cm}.074$
$2,196^{ccm} = 0^{cm}.002196.$
$9^{cdm} = 0^{cm}.009.$
$795^{ccm} = 0^{cm}.000795.$

Exercise 4.

Reduce to cubic decimetres the following :

$5^{cm}.4679$; $1,767^{ccm}.04$; $6,917,805^{cmm}$; $3^{cm}.06$; $16^{cm}.3$; 14^{cm}.

$5^{cm}.4679 = 5,467^{cdm}.9.$
$1,767^{ccm}.04 = 1^{cdm}.76704.$
$6,917,805^{cmm}. = 6^{cdm}.917\,805.$
$3^{cm}.06 = 3,060^{cdm}.$
$16^{cm}.3 = 16,300^{cdm}.$
$14^{cm}. = 1.000^{cdm} \times 14 = 14,000^{cdm}.$

Exercise 5.

Reduce to cubic centimetres :

1. $63^{cm}.279\,784\,5$; $4^{cdm}.9376$; $3^{cm}.276$; $9^{cdm}.64$; $15^{cm}.65$; $201^{cdm}.8$.

$63^{cm}.2797845 = 63{,}279{,}784^{ccm}.5$
$4^{cdm}.9376 = 4{,}937^{ccm}.6$
$3^{cm}.276 = 3{,}276{,}000^{ccm}.$
$9^{cdm}.64 = 9{,}640^{ccm}.$
$15^{cm}.65 = 15{,}650{,}000^{ccm}.$
$201^{cdm}.8 = 201{,}800^{ccm}.$

2. 12^{cm}; 63^{cdm}.

12^{cm} or $1{,}000{,}000^{ccm} \times 12 = 12{,}000{,}000^{ccm}$.
63^{cdm} or $1{,}000^{ccm} \times 63 = 63{,}000^{ccm}$.

Exercise 6.

1. How many cubic centimetres and cubic decimetres in 7 cubic metres?

In 7^{cm}, there are : $7{,}000{,}000^{ccm}$; $7{,}000^{cdm}$.

2. How many cubic decimetres and cubic centimetres in $16^{cm}.4764$?

In $16^{cm}.4764$, there are : $16{,}476^{cdm}.4$; $16{,}476{,}400^{ccm}$.

Exercise 7.

1. Add : $2^{cm}.970 + 108^{cdm}.0625 + 13^{cm}.122$.

$2^{cm}.970$	or	$2^{cm}.970$
$108^{cdm}.0625$	—	$0^{cm}.108\,062\,5$
$13^{cm}.122$	—	$13^{cm}.122$
In all :		$16^{cm}.200\,062\,5$

2. A block of marble measures $0^{cm}.779625$; how many pieces can it be divided into, supposing each piece to measure $2{,}531^{ccm}.25$?

253125) 77962500 (308
759375
.2025000
2025000
.....

The block measures :
$0^{cm}.779625$ or 779.625^{ccm}.
We get :
$$\frac{779625}{2531.25} = 308 \text{ pieces.}$$

Answer : 308 pieces.

3. Give in cubic centimetres and in cubic metres the volume of 19 cases each measuring $968^{cdm}.75$.

968750
19
8718750
968750
18 406 250

Each case measures :
$968^{cdm}.75$ or $968{,}750^{ccm}$.
And the 19 measure :
$968{,}750 \times 19 = 18{,}406{,}250^{ccm}$.
or $18^{cm}.406\,250$.

Answer : $18{,}406{,}250^{ccm}$ or $18^{cm}.406\,250$.

4. Two workmen extracted from a quarry the first day of their work 15 cubic metres 640 cubic decimetres of stone, the second day, 19 cubic metres 15 cubic decimetres; the third day, 24 cubic metres 3 cubic decimetres and the fourth day, 18 cubic metres. What is the total amount of stone extracted?

15.640
19.015
24.003
18
76.658

The workmen extracted in all :
$15^{cm}.640 + 19^{cm}.015 + 24^{cm}.003 + 18^{cm}. = 76^{cm}.658$.

Answer : $76^{cm}.658$.

5. A tank measures $2^{m}.35$ long, $2^{m}.07$ wide and $1^{m}.80$ high. How many cubic metres and cubic decimetres of water will it hold?

2.35 × 2.07 = 4.8645 ; 4.8645 × 1.80 = 8.756100

The tank has a volume of :

$2.35 \times 2.07 \times 1.80 = 8^{cm}.7561$

or : $8{,}756^{cdm}.1$.

Answer : $8^{cm}.7561$
or : $8{,}756^{cdm}.1$

6. To what depth has a ditch been digged measuring $165^{m}.30$ long, $2^{m}.15$ wide and from which $177^{cm}.6975$ of earth has been taken away?

165.3 × 2.15 = 355.395

The ditch has a surface of :
$165.3 \times 2.15 = 355^{qm}.395$;
and the ditch has a depth of :

$\frac{177.6975}{355.395} = 0^{m}.5$ or $0^{m}.50$

355395) 177697.5 (0.5
177.697.5
.....

Answer : $0^{m}.50$.

7. A wall of $48^{cm}.2205$ is built with bricks of $1^{cdm}.83$. How many bricks have been employed?

183) 4822050 (26350
366
1162
1098
..640
549
.915
915
...0

The wall has a volume of :
$48^{cm}.2205$ or $48{,}220^{cdm}.5$.

There are needed :

$\frac{48220.5}{1.83} = 26{,}350$ bricks.

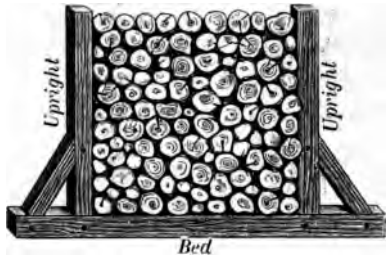
Answer : 26,350 bricks.

Firewood measure.

The measure used for expressing the volume of a pile of firewood is called the **stere** (*st*).

It is equal to a *cubic metre*.

It is composed of a frame with two uprights fixed in a flat bed; each upright being one metre long and also one metre apart.



There is only one multiple:

The **deca***stere* (*Dst*) = **10** steres.

and only one sub-multiple:

The **deci***stere* (*dst*) = one *tenth* of a stere.

The decastere = 10 steres or 100 decisteres.

The stere = 10 decisteres.

RECAPITULATORY TABLE OF THE MEASURE OF FIREWOOD

Multiple		Sub-multiple
Deca	Stere	Deci
10	**1**	**0.1 or $\frac{1}{10}$**

TO READ AND WRITE A NUMBER EXPRESSING STERES

Keeping the preceding table in mind, the rules for the stere are applied in the same manner as those for the metre, its multiples and sub-multiples.

Thus :

$37^{st}.8$ is read 37 steres 8 decisteres.

$4^{Dst}.74$ — 4 decasteres 74 decisteres.

and

28 steres 5 decisteres are written $28^{st}.5$.

7 decasteres 9 decisteres — $7^{Dst}.09$.

The nought (**0**) replaces the missing steres.

CHANGING THE UNIT

Follow the same plan as for the metre, its multiples and sub-multiples.

Examples :

1. Reduce $3^{Dst}.54$ to *steres*.

Since steres come immediately to the right of decasteres, move the point one place to the right, and we get :

$35^{st}.4$.

2. Reduce $75^{st}.8$ to *decasteres*.

Decasteres come immediately to the left of steres; move the point one place to the left, and we get :

$7^{Dst}.58$.

EXERCISES ON FIREWOOD MEASURE

Exercise 1.

$7^{st}.5$	is read :	7 steres 5 decisteres.
$37^{Dst}.6$	—	37 decasteres 6 steres.
$0^{st}.7$	—	0 steres 7 decisteres.
$18^{Dst}.07$	—	18 decasteres 7 decisteres.
9^{dst}	—	9 decisteres.
$0^{Dst}.69$	—	0 decasteres 69 decisteres.

Exercise 2.

18 steres 7 decisteres	are written	$18^{st}.7$.
5 decisteres	—	5^{dst}.
19 decasteres 5 steres	—	$19^{Dst}.5$.
7 decasteres 2 decisteres	—	$7^{Dst}.02$.

Exercise 3.

Reduce to steres :

$3^{Dst}.96$; 27^{dst}; 7^{dst}; 17^{Dst}.

$3^{Dst}.96 = 39^{st}.6$.
$27^{dst} = 2^{st}.7$.
$7^{dst} = 0^{st}.7$.
$17^{Dst} = 170^{st}$ $(10 \times 17 = 170^{st})$

Exercise 4.

Reduce to decasteres :

$763^{st}.6$; 607^{dst}; 8^{st}; 5^{dst}.

$763^{st}.6 = 76^{Dst}.36$.
$607^{dst} = 6^{Dst}.07$.
$8^{st} = 0^{Dst}.8$.
$5^{dst} = 0^{Dst}.05$.

Exercise 5.

Reduce to decisteres :

$63^{st}.7$; $2^{Dst}.67$; 4^{Dst}; 97^{st}.

$63^{st}.7 = 637^{dst}$.
$2^{Dst}.67 = 267^{dst}$.
$4^{Dst} = 400^{dst}$ ($100 \times 4 = 400^{dst}$).
$97^{st} = 970^{dst}$ ($10 \times 97 = 970^{dst}$).

Exercise 6.

How many decisteres and steres are there in 5 decasteres?

$5^{Dst} = 500^{dst} = 50^{st}$.

How many steres and decisteres in 8^{cm}?

In 8^{cm}, there are: 8^{st}; 80^{dst}.

Exercise 7.

1. A timber merchant sold 13 st. 5, 3 Dst. 7, 273 decisteres and 8 Dst. 36 dst. of wood. How many steres did he sell in all?

13.5
37
27.3
83.6
161.4

He sold :
$13^{st}.5 + 37^{st} + 27^{st}.3 + 83^{st}.6 = 161^{st}.4$.

Answer : $161^{st}.4$.

2. How much remains if 15 steres 7 decisteres are taken away from a pile of wood containing 83 decasteres 3 steres?

833
15.7
817.3

The pile contains 833^{st};
from this is taken $15^{st}.7$;
there remains $833^{st} - 15^{st}.7 = 817^{st}.3$.

Answer : $817^{st}.3$.

3. Wood is piled under a shed $2^{m}.25$ long, $1^{m}.45$ wide and $1^{m}.60$ high. Give the volume of the wood in steres and decisteres.

1.45
2.25
725
290
290
3.2625
1.6
195750
32625
5.22000

The pile has a volume of :

$1.45 \times 2.25 \times 1.60 = 5^{cm}.220.$

$1^{cm} = 1^{st}.$

$5^{cm}.220 = 5^{st}.220.$

$1^{st} = 10^{dst},$

therefore we have $52^{dst}.20.$

Answer : $5^{st}.22$ or $52^{dst}.20.$

4. Pieces of wood $1^{m}14$ long are piled between the two supports of a stere. To what height will a stere of this wood reach?

114) 1000 (.87
912
.880
798
.82

Since the supports are 1 metre apart, the base covered by the wood has a surface of :

$1.14 \times 1 = 1^{sqm}.14.$

The required amount of wood has a content of :

1^{st} or 1^{cm};

therefore the height $= \frac{1}{1.14} = 0^{m}.87.$

Answer : $0^{m}.87.$

CHAPTER V

MEASURES OF CAPACITY

The capacity or content of a vessel is its internal volume.

The principal unit of the measures of capacity is the **litre** (*l*) [1].

The litre has a capacity equal to that of a *cubic decimetre*.

This can easily be proved. Take a cubic decimetre filled with water and pour into a litre; you will find that the liquid will exactly fill the vessel.

MULTIPLES OF THE LITRE

The secondary units of capacity larger than the litre are :

---

1. LITRE taken from the Latin *litra*.

The **deca***litre* (*Dl*) which equals **10** litres.
The **hecto***litre* (*Hl*) — — **100** —

Remark.—These multiples are units each ten times larger than its preceding sub-multiple.

Consequently :

The decalitre equals 10 litres.
The hectolitre — 10 decalitres.

SUB-MULTIPLES OF THE LITRE

The secondary units smaller than the litre are :

The **deci***litre* (*dl*) which is the *tenth* part of the litre ($0^{l}.1$).
The **centi***litre* (*cl*) which is the *hundredth* part of the litre ($0^{l}.01$).

Remark.—These measures are each ten times smaller than its preceding multiple.

Thus :

In one litre, there are : 10 decilitres.
In one decilitre, — 10 centilitres.

RECAPITULATORY TABLE OF THE MEASURES OF CAPACITY

Multiples.			Sub-multiples.	
Hecto	deca	litre.	deci	centi
100	10	1	0.1	0.01
			$\frac{1}{10}$	$\frac{1}{100}$

TO READ A NUMBER EXPRESSING CAPACITY

To read a number expressing capacity, read first the whole part to which you give the name of the principal unit, then read the decimal part, adding the name of the last unit it contains.

Examples :

1. $827^{l}.36$,

read :

eight hundred and twenty seven litres, thirty six centilitres.

2. 43^{l},

read :

forty three litres.

And :

$3^{Hl}.42$, read : 3 hectolitres 42 litres.
$15^{Dl}.8$, — 15 decalitres 8 litres.
$0^{l}.25$, — 0 litres 25 centilitres.
$5^{dl}.8$, — 5 decilitres 8 centilitres.

TO WRITE A NUMBER EXPRESSING CAPACITY

To write a number expressing capacity, write first the principal units, then the decimal point and afterwards the decimal part, taking care to replace by noughts the units which are missing.

Examples :

1. For 244 litres 13 centilitres, write : $244^{l}.13$.
   — 18 decalitres 3 litres, — $18^{Dl}.3$.
   — 85 litres 7 centilitres, — $85^{l}.07$.

   The nought (**0**) replaces the decilitres which are missing.

2. For 9 hectolitres 6 litres, write : $9^{Hl}.06$.

   The nought (**0**) replaces the decalitres which are missing.

3. For 0 decilitres 8 centilitres, write : $0^{dl}.8$.

   The nought (**0**) replaces the decilitres which are missing.

Remark.—To read and write a number expressing capacity we must observe, on the recapitulatory table of measures of capacity, that all the units succeed each other, from right to left, from the lowest to the highest.

CHANGING THE UNIT

To reduce a number representing certain units of capacity into units of another order, carry the decimal point to the right hand of the figure of the required units, 1, 2, 3... places either to the right or the left.

Examples :

1. Reduce $7,864^{l}.9$ to *hectolitres.*

We know that the hectolitres occupy the second row to the eft of the litres; carry the decimal point two places to the left and we obtain :

$78^{Hl}.649$.

2. Write in *litres*, $7^{Dl}.43$.

Since the litres occupy the first row to the right of the decalitres, we displace the decimal point one place to the right to obtain :

$74^{l}.3$.

3. How many *litres* in $27^{Hl}.3$?

The litres occupy two rows to the right of the hectolitres; carry the decimal point two places to the right, but as there is only one figure add one nought (**0**) and the result is :

2,73**0** litres.

4. Convert $19^{l}.7$ into *hectolitres*.

The decimal point must be displaced two rows to the left and as the units are missing they are replaced by a nought (**0**) and the result is :

$0^{Hl}.197$.

5. Reduce 7 hectolitres to *litres*.

$$7^{Hl} = 100^{l} \times 7 = 700^{l}.$$

CHOICE OF A UNIT OF CAPACITY

We express in *decilitres* and *centilitres* the capacity of a glass or of a tube.

To measure liquids (wine, cider. beer, milk, oil) or dry vegetables, grains and seeds, retailers use the litre as principal unit.

In wholesale trade these goods are measured by decalitres or hectolitres.

Remark :

1 *cubic* metre equals $1{,}000^{l}$ or 100^{Dl} or 10^{Hl}.

1 *cubic* decimetre equals 1^{l} or 10^{dl} or 100^{cl}.

1 *cubic* centimetre equals $\frac{1}{10}$ of the centilitre.

ACTUAL MEASURES OF CAPACITY

The measures of capacity which exist in trade or for industrial purposes run from the *hectolitre* to the *centilitre*.

They are given in the following table :

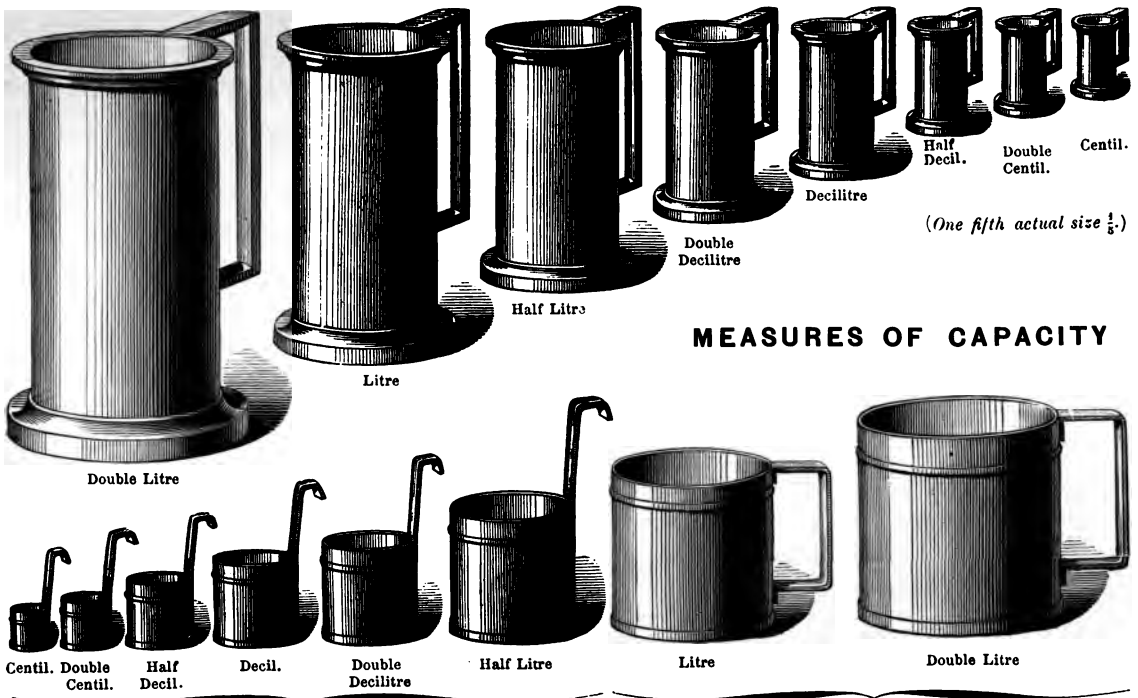
Hectolitre, 100^{l}.	
Half hectolitre, 50^{l}.	
Double decalitre, 20^{l}.	**Double decilitre,** $0^{l}.2$
Decalitre, 10^{l}.	**Decilitre,** $0^{l}.1$
Half decalitre, 5^{l}.	**Half decilitre,** $0^{l}.05$
Double litre, 2^{l}.	**Double centilitre,** $0^{l}.02$
Litre, 1^{l}.	**Centilitre,** $0^{l}.01$
Half litre, $0^{l}.5$.	

Remark.—The measures are either *double* or *half* the value of the multiples or the sub-multiples of the litre. All possible capacities can be measured by them.

These measures are made :

Of tin. These are for liquors, wines, alcohol. Their internal height is double that of the internal diameter

Of tin. Employed for measuring oil or milk. Their internal height equals the internal diameter.



(*One fifth actual size* $\frac{1}{5}$.)

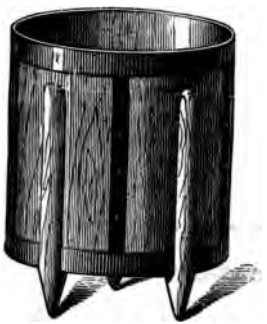
MEASURES OF CAPACITY

Tin Measures for milk

Tin Measures for oil

MEASURES OF CAPACITY

Wooden Measures for grain.



Hectolitre

Half Hectolitre

Double Decalitre

(One eighteenth actual size $\frac{4}{18}$.)

Half Decilitre

Decilitre

Double Decilitre

Half Litre

Litre

Double Litre

Half Decalitre

Decalitre

Of wood or of *sheet iron*. For measuring grain, dry vegetables, beans, peas, coal; the internal height and the internal diameter are equal.

EXERCISES ON THE MEASURES OF CAPACITY

Exercise 1.

To read numbers expressing capacity :

For	$18^{l}.50$,	read :	18 litres 50 centilitres.
—	$7^{Dl}.9$,	—	7 decalitres 9 litres.
—	$15^{Hl}.75$,	—	15 hectolitres 75 litres.
—	$0^{Hl}.15$,	—	0 hectolitres 15 litres.
—	$7^{dl}.6$,	—	7 decilitres 6 centilitres.
—	$123^{l}.06$,	—	123 litres 6 centilitres.
—	$3^{Hl}.07$,	—	3 hectolitres 7 litres.
—	71^{cl},	—	71 centilitres.
—	$2^{Dl}.65$,	—	2 decalitres 65 decilitres.
—	$0^{Dl}.8$,	—	0 decalitres 8 litres.

Exercise 2.

To write numbers expressing capacity :

For	29 litres 35 centilitres,	write :	$29^{l}.35$.
—	15 decalitres 8 litres,	—	$15^{Dl}.8$.
—	19 decilitres 5 centilitres,	—	$19^{dl}.5$.
—	32 hectolitres 27 litres,	—	$32^{Hl}.27$.
—	8 litres 2 centilitres,	—	$8^{l}.02$.
—	2 hectolitres 5 litres,	—	$2^{Hl}.05$.

Exercise 3.

Convert into litres the following :

1. $67^{Dl}.84$; $12^{dl}.5$; 6^{dl}; $8^{Hl}.23$; 215^{cl}; 15^{cl}.

$67^{Dl}.84 = 678^{l}.4.$
$12^{dl}.5 = 1^{l}.25.$
$6^{dl} = 0^{l}.6.$
$8^{Hl}.23 = 823^{l}.$
$215^{cl} = 2^{l}.15.$
$15^{cl} = 0^{l}.15.$

2. 83^{Hl}; 217^{Dl}.

83^{Hl} or $100^{l} \times 83 = 8{,}300^{l}.$
217^{Dl} — $10^{l} \times 217 = 2{,}170.$

Exercise 4.

Reduce to hectolitres :

$237^{l}.25$; $287^{Dl}.9$; 215^{dl}; 63^{l}; 7^{Dl}; 9^{l}.

$237^{l}.25 = 2^{Hl}.3725.$
$287_{Dl}.9 = 28^{Hl}.79.$
$215^{dl} = 0^{Hl}.215.$
$63^{l} = 0^{Hl}.63.$
$7^{Dl} = 0^{Hl}.7.$
$9^{l} = 0^{Hl}.09.$

Exercise 5.

Reduce to decalitres :

$637^{l}.5$; $23^{Hl}.76$; 8^{Hl}.

$637^{l}.5 = 63^{Dl}.75.$
$23^{Hl}.76 = 237^{Dl}.6.$
8^{Hl} or $10^{Dl} \times 8 = 80^{Dl}.$

Exercise 6.

Reduce to decilitres :

$7^{l}.47$; 185^{cl}; $9^{Dl}.63$; 5^{cl}; 8^{Dl}; 7^{l}.

$7^{l}.47 = 74^{dl}.7.$
$185^{cl} = 18^{dl}.5.$
$9^{Dl}.63 = 963^{dl}.$
$5^{cl} = 0^{dl}.5.$
$8^{Dl} = 100^{dl} \times 8 = 800^{dl}.$
$7^{l} = 10^{dl} \times 7 = 70^{dl}.$

Exercise 7.

How many litres and decalitres in 7 hectolitres?

In 7^{Hl}, there are : 700^{l}; 70^{Dl}.

How many decalitres and litres in $5^{Hl}.4$?

In $5^{Hl}.4$, there are : 54^{Dl}; 540^{l}.

How many decilitres and centilitres in 17 litres ?

In 17^{l}, there are : 170^{dl}; $1{,}700^{cl}$.

How many centilitres and decilitres in $8^{l}.5$?

In $8^{l}.5$, there are : 850^{cl}; 85^{dl}.

Exercise 8.

How many litres, decalitres and hectolitres in 1 cubic metre?

In 1^{cm}, there are : $1{,}000^{cdm}$ or $1{,}000^{l}$ or 100^{Dl} or 10^{Hl}.

How many hectolitres, litres and decalitres in 7 cubic metres?

In 7^{cm}, there are : 70^{Hl}; $7{,}000^{l}$; 700^{Dl}.

How many litres, decalitres and hectolitres in 8cubic metres 105 cubic decimetres?

In $8^{cm}.105$, there are : $8,105^{cdm}$ or $8,105^{l}$ or $810^{Dl}.5$ or $81^{Hl}.05$.

How many decalitres, hectolitres and litres in $7^{cm}.235$?

In $7^{cm}.235$, there are : $723^{Dl}.5$; $72^{Hl}.35$; $7,235^{l}$.

Exercise 9.

1. Add :

6 hectolitres 498 decilitres; 1,961 litres 87 centilitres and 98 decalitres 38 decilitres.

$$\begin{aligned} 6^{Hl}.498 &= 649^{l}.8 \\ 1,961^{l}.87 &= 1,961^{l}.87 \\ 98^{Dl}.38 &= 983^{l}.8 \\ \text{In all :} & \quad 3,595^{l}.47 \end{aligned}$$

Answer : $3,595^{l}.47$

2. Give in decalitres the difference in capacity of 2 casks of wine, one containing $2^{Hl}.4367$ and the other $17^{Dl}.253$.

The first cask contains :

$2^{Hl}.4367$ or $243^{l}.67$

The second cask $17^{Dl}.253$ or $172^{l}.53$

The difference in capacity is : $.71^{l}.14$

or $7^{Dl}.114$

Answer : $7^{Dl}.114$.

3. A shed holds $414^{Hl}.4128$ of wheat, how many

sacks can one fill, supposing each sack can contain $13^{Dl}.632$?

13632) 4144128 (304
40896
..54528
54528
.....

The shed holds :
$414^{Hl}.4128$ or $41,441^{l}.28$ of wheat.
A sack can hold :
$13^{Dl}.632$ or $136^{l}.32$,
There will be needed :
$$\frac{41441.28}{136.32} = 304 \text{ sacks.}$$

Answer : 304 sacks.

4. A tank measures $1^{m}.42$ high, $1^{m}.10$ long and $0^{m}.53$ wide. How many litres of water can it hold?

1.42
1.10
1420
142
1.5620

1.562
0.53
4686
7810
0.82786

The tank has a volume of :
$1.42 \times 1.10 \times 0.53 = 0^{cm}.82786$
or $827^{cdm}.86$.
So many cubic decimetres, means so many litres or $827^{l}.86$

Answer : $827^{l}.86$.

5. A tank holds 15 hectolitres 64 litres of wine. First 22 decalitres are drawn, secondly 7 hectolitres and lastly 315 litres. How many litres of wine does the tank still contain?

220
700
315
1235

1564
1235
.329

The tank holds 15 $^{l}.64$ or $1,564^{l}$.
There is drawn :
$220^{l} + 700^{l} + 315^{l} : 1,235^{l}$.
There remains therefore :
$1,564^{l} - 1,235^{l} = 329^{l}$.

Answer : 329 litres of wine.

6. How many bottles will be needed to empty a cask holding 2 hectolitres 25 litres of wine supposing each bottle to hold 75 centilitres?

75) 22500 (300
225
...00

The cask holds : 225^{l}
and a bottle $0^{l}.75$.
The quantity of bottles needed will be :

$$\frac{225}{0.75} = 300 \text{ bottles.}$$

Answer : 300 bottles.

7. A vineyard produced 15 barrels of red wine of 21 decalitres 8 litres each, and ten barrels of white wine of 2 hectolitres 20 litres each. What is the total amount, in hectolitres, of wine produced?

218		Of red wine there are :
15		$218^{l} \times 15$: $3,270^{l}$.
1090	3270	Of white wine : $220^{l} \times 10$: $2,200^{l}$.
218	2200	And together : $3270^{l} + 2200^{l}$: $5,470^{l}$
3270	5470	*Answer :* $5,470^{l}$.

8. A box measures $1^{m}.40$ long, $0^{m}.60$ wide and $0^{m}.50$ deep. How many litres and double decalitres can it contain?

1.4
0.6
0.84
0.5
0.420

The box has a volume of :
$1.40 \times 0.6 \times 0.5 = 0^{cm}.420$ or 420^{cdm}.
and a capacity of 420^{l}.
It can hold $\frac{420}{20} = 21^{DDl}$.

Answer : { 1. 420 litres.
2. 21 double decalitres.

9. A man drinks each day $1\frac{1}{2}$ litre of milk. How many litres of milk will he drink, first, weekly; secondly, yearly?

1.5	10.5
7	52
10.5	210
	525
	546.0

The weekly consumption :

$1\frac{1}{2}$ litre or $1^{l}.5 \times 7 = 10^{l}.5$.

And in a year, $10^{l}.5 \times 52 = 546^{l}$.

Answer: Weekly $10^{l}.5$.
Yearly 546^{l}.

CHAPTER VI

WEIGHTS

The weights have for principal unit the **gramme** (*g*).

A gramme is the weight of a *cubic centimetre of distilled water* weighed in a vacuum and taken at its maximum point of density, 4° centigrade.

Thus the gramme has been determined in a most exact manner.

MULTIPLES OF THE GRAMME

The secondary units of weights greater than the gramme are :

The **deca***gramme*	(*Dg*)	=	**10**	*grammes.*
The **hecto***gramme*	(*Hg*)	=	**100**	—
The **kilo***gramme*	(*Kg*)	=	**1,000**	—
The **myria***gramme*	(*Mg*)	=	**10,000**	—

Remark.—Each of these units is ten times greater than its immediate sub-multiple.

Thus :

The decagramme = 10 grammes;
The hectogramme = 10 decagrammes;
The kilogramme = 10 hectogrammes;
The myriagramme = 10 kilogrammes;

Or again :

The decagramme = 10^{g};
The hectogramme = 10^{Dg} or 100^{g};
The kilogramme = 10^{Hg} or 100^{Dg} or $1{,}000^{g.}$;
The myriagramme = 10^{Kg} or 100^{Hg}, or $1{,}000^{Dg.}$ or $10{,}000^{g.}$.

SUB-MULTIPLES OF THE GRAMME

The sub-multiples of the gramme are :

The **deci***gramme* (*dg*) which is the *tenth* part of the *gramme* (**0^{g}.1**).
The **centi***gramme* (*cg*) which is the *hundredth* part of the *gramme* (**0^{g}.01**).
The **milli***gramme* (*mg*) which is the *thousandth* part of the *gramme* (**0^{g}.001**).

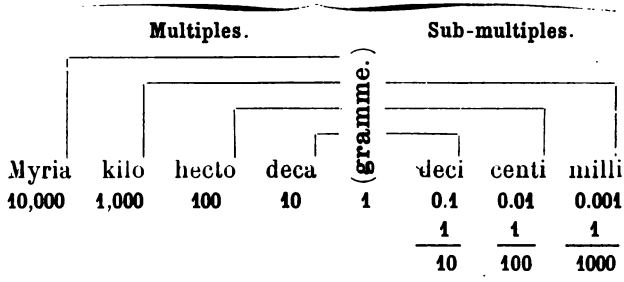
Remark.—Each of these measures is ten times smaller than its immediate multiple.

The decigramme equals 10 centigrammes.
The centigramme — 10 milligrammes.

Or again :

1 gramme equals 10^{dg} or 100^{cg} or $1{,}000^{mg}$.
1 decigramme — 10^{cg} or 100^{mg}.

RECAPITULATORY TABLE OF THE WEIGHTS



TO READ AND TO WRITE A NUMBER EXPRESSING WEIGHT

To read and write a number expressing weight the rules to follow are the same as those given for reading and writing a number expressing capacity, applying the above table.

Consequently :

$3^{g}.18$, is read : *three grammes eighteen centigrammes.*
$9^{Dg},05$, — *nine decagrammes five decigrammes.*
$13^{Kg}.425$, — 13 kilogrammes 425 grammes.
84^{cg}, — 84 centigrammes.
$0^{Kg}.70$, — 0 kilogrammes 70 decagrammes.
$3^{Hg}.15$, — 3 hectogrammes 15 grammes.
$2^{dg}.45$ — 2 decigrammes 45 milligrammes.

And :

73 grammes 252 milligrammes are written : $73^{g}.252$

18 kilogrammes 315 grammes — $18^{Kg}.315$

4 grammes 2 centigrammes -- $4^{g}.02$

The nought (**O**) replaces the decigrammes.

24 kilogrammes 25 grammes, are written : $24^{Kg}.025$

The nought (**O**) replaces the hectogrammes.

5 decigrammes 9 milligrammes are written : $5^{dg}.09$

The nought (**O**) replaces the centigrammes.

0 grammes 15 centigrammes are written : $0^{g}.15$

The nought (**O**) replaces the principal units.

CHANGING THE UNIT

This is done in the same way as for the measures of capacity, and applying the recapitulatory table of the measures of weights.

1. Thus : Reduce $5{,}793^{g}.5$ to *kilogrammes*.

We know that the kilogrammes occupy the third row to the left of the grammes, carry the decimal point three rows to the left and obtain :

$5^{Kg}.7935$.

2. Reduce $3^{Kg}.573$ to *decagrammes*.

The decagrammes occupying the second row to the right of the kilogrammes, we move the decimal point two places to the right to obtain :

$357^{Dg}.3$.

3. Convert into *grammes* $978^{Kg}.54$.

The grammes occupy the third row to the right of the kilogrammes; the decimal point should be carried three places to the right and as there are only two figures a ***nought*** (**0** is added and we get :

$978{,}54\mathbf{0}^{g}$.

4. Write in *kilogrammes* 23 grammes.

The grammes occupy the third row to the right of the kilogrammes, three decimal figures are therefore needed; as only two figures exist a nought (**O**) must be added to make the third.

And as the principal unit is not expressed replace it by a nought (**O**) and we get :

$O^{Kg}.O23$

5. $45^{g}.65$ will be in decigrammes : — $456^{dg}.5$

$87^{Kg}.69$ will be in hectogrammes : — $876^{Hg}.9$

CHOICE OF A UNIT

The *gramme* and its sub-multiples are employed by chemists and by jewellers.

The *kilogramme* is the unit commonly used in trade and industry.

The large weights are expressed in *quintals* and in *tonnes*.

The *quintal* is the weight of 100^{Kg}.
The *tonne* — — $1{,}000^{Kg}$.

We say :

A quintal of hay.
A tonne of coal.

Remark.

The gramme is the weight of 1 cubic centimetre of water.
The kilogramme — 1 cubic decimetre —
The tonne — 1 cubic metre —

ACTUAL WEIGHTS

These run from 50 kilogrammes to 1 milligramme and are as follow :

50^{Kg}	
20^{Kg}	
10^{Kg}	
5^{Kg}	
2^{Kg}	
1^{Kg}	
$\frac{1}{2}^{Kg}$ or 500^{g}.	
2^{Hg} — 200^{g}.	
1^{Hg} — 100^{g}.	
$\frac{1}{2}^{Hg}$ — 50^{g}.	
2^{Dg} — 20^{g}.	
1^{Dg} — 10^{g}.	
$\frac{1}{2}^{Dg}$ — 5^{g}.	
	2^{g}
	1^{g}
	$0^{g}.5$
	2^{dg} or $0^{g}.2$
	1^{dg} — $0^{g}.1$
	$\frac{1}{2}^{dg}$ — $0^{g}.05$
	2^{cg} — $0^{g}.02$
	1^{cg} — $0^{g}.01$
	$\frac{1}{2}^{cg}$ — $0^{g}.005$
	2^{mg} — $0^{g}.002$
	1^{mg} — $0^{g}.001$

With the above any weight can be determined. These weights are made :

Of *cast iron*,

Rectangular base for the weights from 50^{Kg} to 20^{Kg}
Hexagonal base — — 20^{Kg} to $\frac{1}{2}^{Hg}$

Of *brass*,

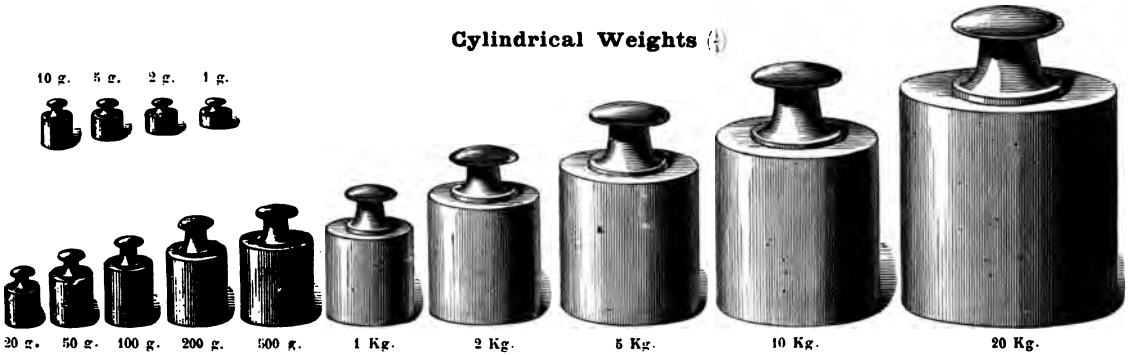
These are cylindrical with a knob; they run from 20^{Kg} to 1^{g}

In the *shape of small sheets*,

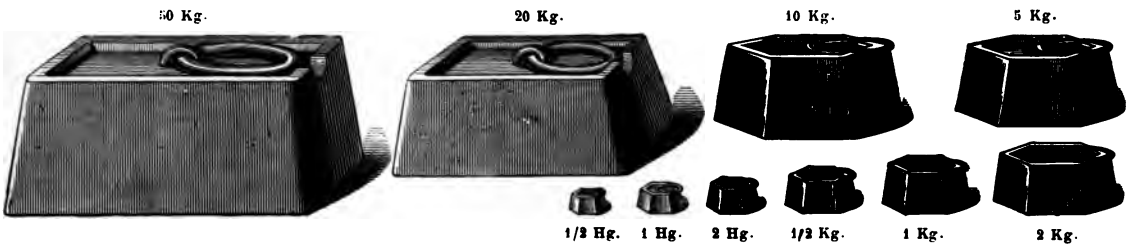
From 5 decigrammes to 1 milligramme.

Each weight bears on its upper face its value.

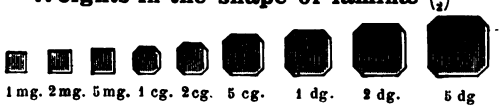
Cylindrical Weights ($\frac{1}{1}$)



Cast iron Weights ($\frac{1}{8}$)



Weights in the shape of laminæ ($\frac{1}{2}$)



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EXERCISES ON WEIGHTS

Exercise 1.

To read numbers expressing weights :

834^{g}.55 are read : 834 grammes 55 centigrammes.
23^{Kg}.518 — 23 kilogrammes 518 grammes.
5^{Hg}.29 — 5 hectogrammes 29 grammes.
13^{Dg}.5 — 13 decagrammes 5 grammes.
27^{cg}.9 — 27 centigrammes 9 milligrammes.
3^{dg}.07 — 3 decigrammes 7 milligrammes.
0^{g}.07 — 0 grammes 7 centigrammes.
18^{Kg}.005 — 18 kilogrammes 5 grammes.
7^{Dg} — 7 decagrammes.

Exercise 2.

To write numbers expressing weights.

813 grammes 5 decigrammes are written : 813^{g}.5.
21 kilogrammes 315 grammes — 21^{Kg}.315.
2 hectogrammes 4 decagrammes — 2^{Hg}.4.
13 decagrammes 2 grammes — 13^{Dg}.2.
17 kilogrammes 7 grammes — 17^{Kg}.007.
5 decigrammes 8 centigrammes — 5^{dg}.8.
123 grammes 16 milligrammes — 123^{g}.016.
6 centigrammes 9 milligrammes — 6^{cg}.9.

Exercise 3.

Reduce to grammes :

1. 3^{Kg}.618 ; 2^{Hg}.7 ; 273^{dg} ; 5^{dg} ; 418^{cg} ; 12^{Dg}.64 ; 4^{Kg}.008 ; 15^{cg}.

3^{Kg}.618 = 3,618^{g}.
2^{Hg}.7 = 270^{g}.
273^{dg} = 27^{g}.3.
5^{dg} = 0^{g}.5.
418^{cg} = 4^{g}.18.
12^{Dg}.64 = 126^{g}.4.
4^{Kg}.008 = 4,008^{g}.
15^{cg} = 0^{g}.15.

2. 8^{Kg}; 4^{Dg}; 3^{Hg}.

8^{Kg} or $1{,}000^{g} \times 8 = 8{,}000^{g}$.
4^{Dg} — $10^{g} \times 4 = 40^{g}$.
3^{Hg} — $100^{g} \times 3 = 300^{g}$.

Exercise 4.

Reduce to kilogrammes :

$6{,}725^{g}.6$; $23^{Hg}.75$; $1{,}259^{Dg}.02$; 7^{g}; $3^{Dg}.5$; $8^{Hg}.15$.

$6{,}725^{g}.6 = 6^{Kg}.7256$.
$23^{Hg}.75 = 2^{Kg}.375$.
$1{,}259^{Dg}.02 = 12^{Kg}.5902$.
$7^{g}. = 0^{Kg}.007$.
$3^{Dg}.5 = 0^{Kg}.035$.
$8^{Hg}.15 = 0^{Kg}.815$.

Exercise 5.

Reduce to hectogrammes :

$375^{g}.24$: $12^{Kg}.615$; $6^{g}.8$; $625^{Dg}.3$; $3^{Dg}.5$.

$375^{g}.24 = 3^{Hg}.7524$.
$12^{Kg}.615 = 126^{Hg}.15$.
$6^{g}.8 = 0^{Hg}.068$.
$625^{Dg}.3 = 62^{Hg}.53$.
$3^{Dg}.5 = 0^{Hg}.35$.

Exercise 6.

Reduce to decigrammes :

$675^{g}.69$; $213^{mg}.5$; $184^{cg}.4$; $3^{mg}.$; 5^{cg}.

$675^{g}.69 = 6{,}756^{dg}.9$
$213^{mg}.5 = 2^{dg}.135$.
$184^{cg}.4 = 18^{dg}.44$.
$3^{mg}. = 0^{dg}.03$.
$5^{cg}. = 0^{dg}.5$.

Exercise 7.

1. How many grammes, hectogrammes and decagrammes in 3 kilogrammes?

In 3^{Kg}, there are : $3{,}000^{g}$; 30^{Hg}; 300^{Dg}.

2. How many hectogrammes, decagrammes and grammes in $17^{Kg}.650$?

In $17^{Kg}.650$, there are : $176^{Hg}.50$; $1{,}765^{Dg}$; $17{,}650^{g}$.

3. How many decigrammes, centigrammes and milligrammes in 3 grammes?

In 3^{g}, there are : 30^{dg}; 300^{cg}; $3{,}000^{mg}$.

4. How many centigrammes, milligrammes and decigrammes in $18^{g}.200$?

In $18^{g}.200$, there are : $1{,}820^{cg}$; $18{,}200^{mg}$; 182^{dg}.

Exercise 8.

1. 3 chests of tea contain respectively 59,854 grammes, 263 hectogrammes and 17 kilogrammes 600 grammes. What is the total weight in kilogrammes?

The first chest contains :	$59{,}854^{g}$.
The second.	$26{,}300^{g}$.
The third.	$17{,}600^{g}$.
In all :	$103{,}754^{g}$.

or $103^{Kg}.754$

Answer : $103^{Kg}.754$.

2. How many tonnes of coal will a train composed

of 20 waggons carry if each waggon carries 6,893 kilogrammes 38 decagrammes?

The 20 waggons will carry :

$6{,}893^{Kg}.38 \times 20 = 137{,}867^{Kg}.60.$

One tonne equals $1{,}000^{Kg}$.

In $137{,}867^{Kg}.60$, there are :

$$\frac{137{,}867^{Kg}.6}{1{,}000} = 137^{T}.8676.$$

Answer : 137 tonnes 8676.

3. How many waggons will be needed to carry 1,066 tonnes 380 kilogrammes if each waggon can hold 2,665Kg.95.

Weight to be carried is :

$1{,}066^{T}\ 380 \times 1{,}000 = 1{,}066{,}380^{Kg}.$

therefore :

$$\frac{1{,}066{,}380}{2665.95} = 400 \text{ waggons.}$$

```
266595) 106638000 (400
        1066380
        .......00
```

Answer : 400 waggons.

4. A vessel full of water weighs 3 kilogrammes 745 grammes and when empty 10 hectogrammes 35 grammes. What is its capacity?

If from the total weight $3^{Kg}.745$ we subtract the weight of the vessel :

$10^{Hg}.35$ or $1^{Kg}.035$,

we have the weight of the water or :

$3^{Kg}.745 - 1^{Kg}.035 = 2^{Kg}.710.$

```
3.745
1.035
2.710
```

Each kilogramme of water corresponds to one litre, the capacity of the vessel is therefore $2^{l}.71$.

Answer : $2^{l}.71$.

5. A grocer sells first $4^{Kg}.250$ of coffee, secondly $87^{Hg}.25$, thirdly 275^{Dg}. What is the total quantity of coffee he sold?

He sold the first time : $4^{Kg}.250$
— — second — : $8^{Kg}.725$
— — third — : $2^{Kg}.75$
In all : $15^{Kg}.725$

Answer : $15^{Kg}.725$.

6. 125 rings, each containing $3^{g}.5096$ of gold are melted down. How many rings each containing $2^{g}.675$ of gold can be made from the mass?

3.5096	2675) 438700 (164	
125	2675	In 125 rings, there are :
175480	17120	$3^{g}.5096 \times 125 = 438^{g}.7$.
70192	16050	With this weight could be made :
35096	.10700	$\frac{438.7}{2.675} = 164$ rings.
438.7000	10700	
	...	

Answer : 164 rings.

7. A bar of iron is $3^{m}.25$ long, 7^{cm} wide and 14^{mm} thick. What is its weight, the cubic decimetre weighing $7^{Kg}.7$?

3.25	0.2275
0.07	0.014
0.2275	9100
	2275
	0.0031850

The bar of iron has a volume of :

$3.25 \times 0.07 \times 0.014 = 0^{cm}.003185$

or $3^{cdm}.185$ and weighs :

$7^{Kg}.7 \times 3.185 = 24^{Kg}.5245$.

3.185	
7.7	
22295	
22295	
24.5245	

Answer : $24^{Kg}.5245$.

8. Knowing that a litre of oil weighs 915^{g}, find: First, the weight of 4 hectolitres 8 decalitres; then the weight of 7 double decalitres, also the weight of 18 litres and lastly the weight of $1^{dl}.6$.

915 × 480 = 439200
915 × 140 = 128100

$4^{Hl}.8$ or 480^{l} of oil weigh:
$915 \times 480 = 439200^{g}$ or $439^{Kg}.200$ (*first answer*).
7^{DDl} or $20 \times 7 = 140$ litres weight:
$915 \times 140 = 128100^{g}$ or $128^{Kg}.100$ (*second answer*).

915 × 18 = 16470
915 × 0.16 = 146.40

18^{l} weigh:
$915 \times 18 = 16470^{g}$. or $16^{Kg}.470$ (*third answer*).
$1^{dl}.6$ or $0^{l}.16$ weighs:
$915 \times 0^{l}.16 = 146^{g}.40$. (*fourth answer*).

9. One side of a triangular field measures 230^{m}. The perpendicular on to this side from the opposite angle is 148^{m}. The field produces 260^{Kg} of grass per are. What would be in quintals the total weight of the yield, if the hay is only $\frac{62}{100}$ of the fresh grass.

230 × 74 = 17020
170.20 × 260 = 44252.00

The field has surface of:
$230 \times 74 = 17020^{qm}$ or $170^{a}.20$.
The yield is:
$260^{Kg} \times 170.20 = 44252^{Kg}$ of grass.
The hay weighs
$$\frac{44252 \times 62}{100} = \frac{2743624}{100} = 27436^{Kg}.24,$$
and in quintals:
$$\frac{27436^{Kg}.24}{100} = 274^{q}.3624.$$

44252 × 62 = 2743624

Answer: $274^{q}.3624$.

10. A vessel full of water weighs $2^{Kg}.650$ and when empty 9^{Hg}; if filled with oil its weight is $2^{Kg}.503$, find the weight of one litre of oil.

2.503
0.900
1.603

175) 160.3 (0.916
1575
..280
175
1050
1050
....

The weight of the water is :
$2^{Kg}.650 - 0^{Kg}.900 = 1^{Kg}.750$.

The capacity of the vessel $1^{l}.750$;

The oil weighs :
$2^{Kg}.503 - 0^{Kg}.900 = 1^{Kg}.603$.

The weight of one litre :
$\frac{1.603}{1.75} = 0^{Kg}.916$

Answer : $0^{Kg}.916$.

IMPORTANT REMARK

It has been explained that the measures of the metric system are derived from the metre.

The *square metre* is a square measuring a metre on each of its sides.

The *are* is a square decametre.

The *cubic metre* is a cube the edges of which measure one metre.

The *litre* has a capacity of a cubic decimetre.

The *gramme* is the weight of one cubic centimetre of water.